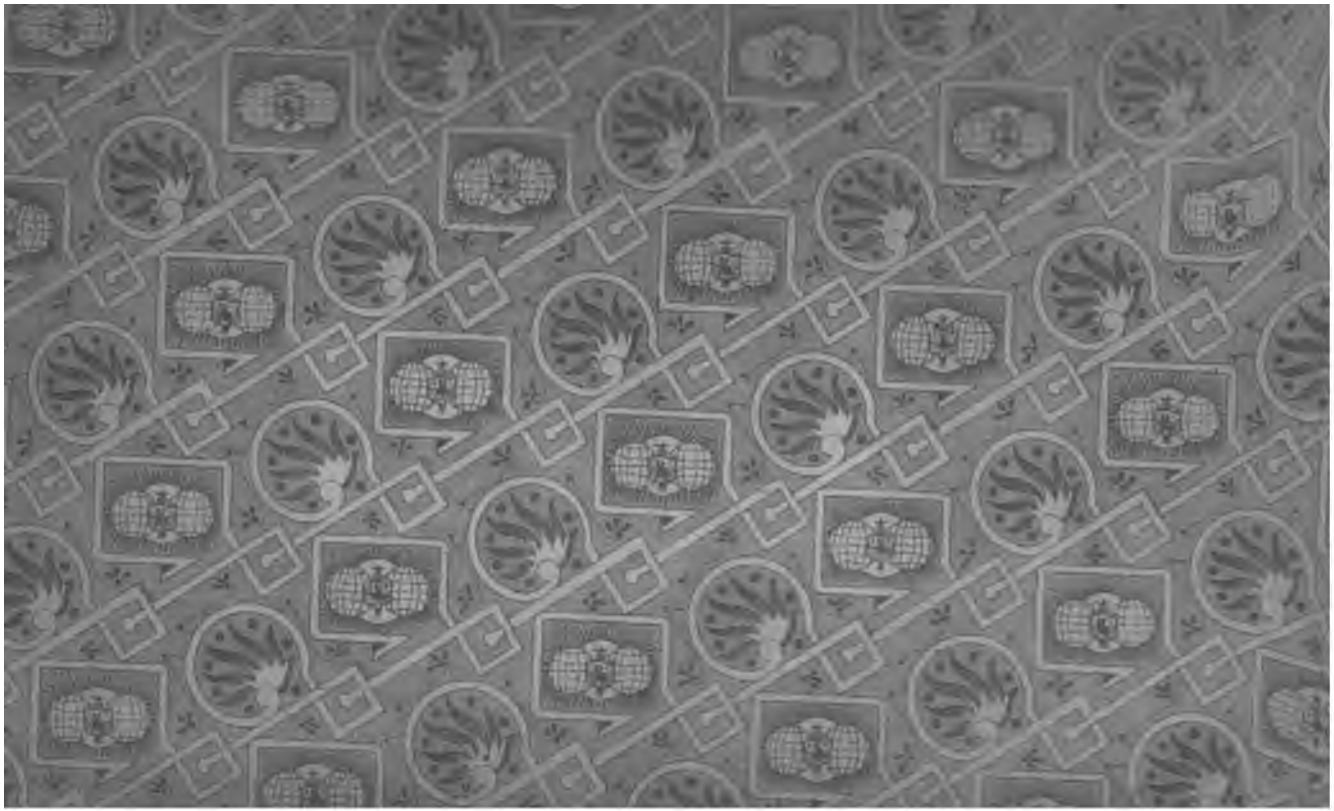

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IN THE

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WITH SPECIAL REFERENCE TO THE APPLICATION OF STRONG CURRENTS.

BY

G. BETTON MASSEY, M.D.,

PHYSICIAN TO THE GYNECOLOGICAL DEPARTMENT OF HOWARD HOSPITAL; LATE ELECTRO-THERAPEUTIST TO THE PHILADELPHIA ORTHOPÆDIC HOSPITAL AND INFIRMARY FOR NERVOUS DISEASES; MEMBER OF THE AMERICAN NEUROLOGICAL ASSOCIATION, OF THE PHILADELPHIA NEUROLOGICAL SOCIETY, OF THE OBSTETRICAL SOCIETY OF PHILADELPHIA, OF THE MEDICAL JURISPRUDENCE SOCIETY, OF THE FRANKLIN INSTITUTE, ETC., ETC.

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PHILADELPHIA AND LONDON:

F. A. DAVIS, PUBLISHER,

1890.

Philadelphia:
The Medical Bulletin Printing House,
1231 Filbert Street.

PREFACE TO FIRST EDITION.

In presenting to the profession what is believed to be the first attempt at a complete treatise on the electrical treatment of the diseases of women, the author deprecates in advance any misapprehension of its scope and claims. Only such conditions receive notice in the treatment of which electricity has recently been urged upon professional favor; and this portion of the work partakes, therefore, more of the nature of a mirror of the author's daily work than of a classical research into the literature of the subject. While the experience of others, particularly of Apostoli, Engelmann, and Laphthorn Smith, has been utilized as a guide and mentor, it is not forgotten that a scientific investigation takes nothing upon hearsay evidence, and that the profession demands proofs rather than theories. It should be stated, also, that the author does not wish to assume the position of recommending the routine use of any one agent or procedure, to the exclusion of other rational remedies, in the medical or surgical treatment of any single class of diseases. It was merely in the interest of

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ELECTRICITY

IN THE

DISEASES OF WOMEN,

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CHAPTER I.

INTRODUCTORY.

A DAWNING reaction from the ultra-mechanical methods of the followers of the late J. Marion Sims was probably instrumental in first attracting earnest attention to electricity as a therapeutic agent in gynecology. It was readily seen that in it lay the possibility of a wide range of direct applications, generally of a harmless nature, and better calculated than any other to touch whatever neurotic element might lurk in a case. Of late, however, a more serious use of the remedy has been added to these milder therapeutic applications, constituting indeed a truly surgical use of electric force. I do not allude to the galvano-cautery, in which the remedial agent is merely caustic heat which happens to be generated by electricity, but to the chemical action of a strong current brought to a focus on the bared surface of a single pole, which has been placed directly at the seat of local disease. The

possibility of using currents of the chemical energy wielded by one hundred, two hundred, and three hundred milliampères, in this perfectly safe and almost painless manner, was first pointed out by Apostoli in descriptions of his method of treating fibroid tumors of the uterus. More recently the same powerful but easily-controlled surgical agency has been employed for the direct treatment of metrorrhagia, chronic metritis and endometritis, stenosis of the os and cervical canal, subinvolution, chronic pelvic indurations, etc., and a conservative view of the results gained is that a most important addition has been made to surgical gynecology.

At the present time, therefore, an unusual degree of professional attention is being directed toward two essentially different means of rendering electrical applications useful in the diseases peculiar to women, the one consisting of a therapeutic use of faradic and weak galvanic currents applied percutaneously or directly to the vagina, uterus and bladder, mainly for the relief of *pain*,—a symptom that prompts most of the plastic and resectional operations, and yet so sadly persists after many of them,—and the other, a surgical disintegration of diseased tissues and neoplasms by strong but accurately-measured currents, the disintegration being so controlled as to cause a mere surface cauterization at a circumscribed spot on the mucous membrane, or to produce an extensive, wholly internal destruction within the body of a tumor.

While it cannot be said that the first-mentioned method of using electric currents in gynecology has not already been extensively tried, it is yet true that circumstances were against anything like an adequate

determination of its value until a very recent date, as the want of reliable means of measurement and dosage made intelligent experiment impossible. Since the general adoption of the milliampère meter (although it can hardly be said to be in sufficiently general use yet), a great stimulus has been given to such applications, and their true field will doubtless be speedily outlined. The scientific use of strong currents, on the other hand, is admittedly in its infancy, and owes its professional favor to the very recent writings of Apostoli and others abroad, and of numerous enthusiastic gynecologists in this country.

It is in the use of galvanic currents especially, whether weak or strong, that recent progress has been attained, and its key-note has been the use of *a single pole for treatment*, the circuit being completed by a non-active pole on the surface. Definite results can thus be secured and accurately predicted beforehand, for the basis of the work has been shifted from theory to observed fact. We know much of the effect of each pole upon tissues in immediate contact with it,—the polar effect,—and but little of the more distant interpolar effects. Gynecological applications of electric currents have, therefore, a distinct advantage over neurological applications,—at least until such time as neurologists shall practice the same boldness in local treatment.

This surgical use of strong currents within the pelvis has already been found to be a desirable substitute for a number of both major and minor gynecological operations,—such, for instance, as laparotomy for fibroid tumors and for hydrosalpinx, curetting, trachelorraphy, application of styptics, caustics or caustic solutions to

the endometrium, etc., the current application being in each case either less fraught with peril to the patient, more quickly curative, or more easily applied and controlled. It is an absolute substitute for sharp curetting in all cases, and, where it can be conveniently performed, this operation is unjustifiable in the future. As compared with caustics and caustic solutions, it possesses the advantages of being easily and absolutely controllable, permitting either an alkaline or an acid caustic action to begin gradually and be terminated at any desired instant, accompanied at the same time by a distant action of a salutary nature. The caustic effect, moreover, may be confined to the interior of the uterine cavity, leaving the cervical mucous membrane untouched, or *vice versâ*, by the use of a form of intra-uterine electrode devised by the author. As a means of controlling hemorrhage from the uterine cavity, whether due to malignant disease or not, powerful positive cauterization is unequalled.

It is true that a full test of the practical utility of electricity in the diseases peculiar to the female sex must show that it is an agent capable of being properly applied without the need of a very great amount of technical skill. The main purpose of this little book is to show that the necessary skill can be readily gained by any one, even the busy general practitioner, if he will but consent to study the remedy in a practical way, and use reasonable care and circumspection in performing the operations. Unfortunately, such a student must also consent to abstain from reading any but the most recent works upon electro-therapeutics, as a certain result of a perusal of many of them is a failure to comprehend the present position of electrical science.

To the gynecologist it is by no means a fault of these works that they are written from the stand-point of the neurologist, for there is no essential difference in the two kinds of work. The real difficulty is a lack of clearness and simplicity that of necessity attended all electrotherapeutic writings before the introduction of the meter. Since its adoption the most intricate laws of electrical science are capable of demonstration to the senses without calculation or figuring, and one may handle a current properly without being an accomplished theoretical electrician.

But, while making light of the necessity of much theoretical knowledge, I do not wish to be understood as implying that an intelligent comprehension of currents and their behavior is not essential to any one who would subject a woman to the influence of the heavy doses now in vogue. They are, unfortunately, too often given at the present time by persons in ignorance of their laws and powers, and I have more than once been simply astounded at the lack of acquaintance with elementary physics on the part of physicians actively engaged in this work. Fortunately, this lack may be overcome by a little earnest work under proper direction, and it is for this purpose that an experimental part of this book has been arranged.

Practical experimentation with currents not only insures their easy control in subsequent work, but furnishes the best means of comparing the three medical currents,—the galvanic, the faradic, and the franklinic; and but little handling of this sort is needed to convince any one that each is an essentially different article of the materia medica.

CHAPTER II.

APPARATUS REQUIRED IN GYNECOLOGICAL APPLICATIONS OF THE GALVANIC CURRENT.

THE preliminary handling and study of the galvanic current that is so essential to intelligent work begins, of course, in a selection of the proper apparatus. This may be somewhat less imposingly complicated than usually supposed. The articles considered necessary by the writer for both experimental and therapeutic work are both inexpensive and simple. The list may be given as follows:—

1. A battery, or the supply terminals of an incandescent electric light circuit. 2. A current controller of proper make. 3. A meter indicating from one to at least five hundred milliampères. 4. For mere experimental work, at least three sizes of cutaneous electrodes, with a sufficient number of conducting cords. A few words may be profitably devoted to each of these articles.

The Battery.—The best stationary battery for all-around medical galvanic work is made up of a suitable number of a kind of cell known among electricians as an "open-circuit" cell,—that is, a cell that will not deteriorate during periods of idleness, that is ever ready to work well, and that possesses the single disadvantage that it requires rest for recuperation after its full power has been taxed. As the full power can never be used in medical work, this one objection has no significance.

The Leclanché (prism or Gonda pattern) is one of the best of this type in general use, and one cannot make a mistake in its purchase. The cell used by Apostoli, as made by Gaiffe, and also in this country by Otto Flemming, is an open-circuit variety, closely following the Leclanché in material points. Neither of these cells require any attention whatever, for long periods of time,

FIG. 1.—LAW CELL. (New form.)

beyond a very rare supply of water and chloride of ammonium, and a still rarer renewal of the cheap zinc rod employed as the negative pole. But of all the cells now on the market by far the best is the Law cell (Fig. 1). After an extended experience with many cells before using batteries of this make, at my private hospital and at the Pennsylvania and Howard Hospitals, I am fully convinced of their superiority over all others for the

purposes of a physician. Their most important features are the indestructibility of the carbon element under ordinary use and the protection of the liquid from evaporation by the hermetically-sealing top. The long-deferred but certain renewal of the expensive manganese element of Leclanché cells that is thus avoided in these cells is but a trifling advantage contrasted with that

FIG. 2.—ELEMENTS OF THE LAW CELL.

of the air-tight seal, for in physicians' batteries, lightly used as compared with bell-ringing cells, the chief foe is evaporation. The nature of the seal permits a ready renewal of the zinc and sal-ammoniac solution when these after long usage have become wasted, and if short-circuiting and splashing are avoided this cell should last the physician indefinitely.

The number of either of these cells required by a physician varies from thirty to seventy or more, according to the scope of the work to be performed. Thirty cells give but little current through the skin of most parts of the body, and the number is mentioned here merely because some physicians seem to be content with very weak galvanic batteries. Forty-five cells give a reasonably strong current for percutaneous or permucous work, but for the heavy currents of electro-cauterization and electro-puncture from fifty to seventy give the best results through the meter and controller, when used in the way described in this work. They are to be set up according to directions accompanying them, on shelves in some permanently secluded place, connected "in series,"—that is, the zinc of the first to the carbon of the second, the zinc of the second to the carbon of the third, and so on until all are connected.* It will then be found that the first carbon and last zinc are unconnected with anything else; to each of these attach a wire and carry the circuit to two binding posts conveniently placed to receive the cords of the electrodes. The post connected with the first carbon will be the positive pole (anode) and the one connected with the last zinc will be the negative pole (kathode) of the battery.

My experience with the gravity cell has convinced me that it is entirely out of place in a physician's battery,

* Although the connecting together of the cells of a permanent battery is so simple a thing if the exact order outlined in the text is observed, cells are frequently ruined by carelessness in this particular. When they are all to be used at once with a current controller in circuit, as advised by the writer, their proper arrangement "in series" is exceedingly simple.

being exceedingly dirty from the constant accumulation of creeping zinc sulphate, and unreliable owing to the rapidity with which evaporation breaks the circuit by depressing the water surface below the horizontally-hung zinc. In each of the other cells the perpendicular arrangement of the elements permits the circuit to remain good as long as any water is left in the jar. The gravity cell is really designed only for continuous "closed-circuit" work, and is only economical when engaged in constant action, under constant supervision, as in telegraph-offices.

What are known as current selectors—that is, devices to select one or any number of cells for use—should be utterly rejected in any kind of medical battery when it is possible to obtain a current controller such as will be described directly, by means of which the current can be varied at will, without shock of any kind. Two wires only are needed when the controller is used, doing away with the great number and intricate arrangement of wires necessitated with the selector.

But, instead of the bulky office battery described, many physicians will doubtless wish a portable one, making battery work possible at the bedside as well as in the office. A first purchase is apt to take this direction, and very properly so, since cases are constantly met with that cannot come to the office. Of the portable batteries, I have been compelled to return again and again to Flemming's zinc-carbon-bichromate battery, as one after the other promising substitute failed to bear the test of time and work. These batteries are made with a selector on the face-board, consisting of a plug-socket over each cell; but where shock is to be avoided

the careful operator will use the whole battery at once, with a controller and meter in circuit, as recommended for the stationary battery. They are usually supplied with a commutator (pole changer) also; but this means of changing the polarity of the electrodes is only essential in electro-diagnosis, and is a positive disadvantage in gynecological applications, as leading to confusion between the poles, and even accidental breaks in the circuit while at work.*

A thirty-cell portable Flemming battery, *freshly charged*, can be made to maintain from one hundred to one hundred and fifty milliampères through a circuit consisting of the patient (from embedded needle to large dispersing electrode) and a meter and controller such as are described in this paper. Two such batteries will give from two hundred to three hundred milliampères under similar circumstances.

The cleaning, re-amalgamating, and refilling that all acid batteries demand every month, and especially when about to be used after a period of inaction, is an obstacle to their comfortable use; but no little satisfaction is given by them after being put or kept in order, as they give a powerful current, considering their small bulk, and the simplicity of their repair makes it possible for the physician to keep them in order himself, without the trouble and expense of sending to the manufacturers. I have one of thirty cells that has been used by me constantly for bedside work for nine years, with but

* The wheel shape of some of these commutators has actually led some physicians to think that the proper way to administer a galvanic current is to place the poles *in situ* and rapidly reverse the current by turning the crank.

two renewals of zincs, and it is yet as good as a new one.

It is probably best to state distinctly in this place that the portable batteries, consisting of small chloride of silver or chloride of ammonium cells, while useful and convenient in administering from five to twenty milliampères at the bedside, are totally inadequate to produce the heavier or even medium currents required in direct intra-pelvic work.

The Current Controller.—This instrument I consider indispensable in the use of heavy currents, and of great value in all forms of galvanic work where shock is to be avoided. Its function is to vary the current at will, by rapidly increasing or decreasing the resistance of the circuit. The older forms were called rheostats, and consisted of coils of wire of known resistance or of glass tubes containing water and a sliding rod. The coils have been entirely discarded for this purpose, for reasons that I will not now enter into, and the tube, while largely in use, has too small a range for heavy currents. The same objection may be urged against the original form of a circular pencil-mark controller devised by the writer about two years ago, and exhibited before the Philadelphia County Medical Society. Its range of resistance adapted it to all percutaneous currents up to fifty milliampères, but not above that point. I have recently succeeded, with Mr. Flemming's assistance, in so improving it as to remove this objection, and it will now vary a current from a fraction of a milliampère to the full strength of the battery, without shock (Fig. 3).

It consists of a porcelain plate provided with a tapering area of soft pencil-mark, broadening and thick-

ening up to the point at which the graphite, now covered with nickel plating, is connected with the circuit by means of a broad spring contact. This area acts as a resisting material, over which a brass contact attached to a crank can be made to pass. When the crank (1, Fig. 3) is placed to the right of the hard-rubber bridge, 2, the contact rests entirely on the porcelain and the circuit is

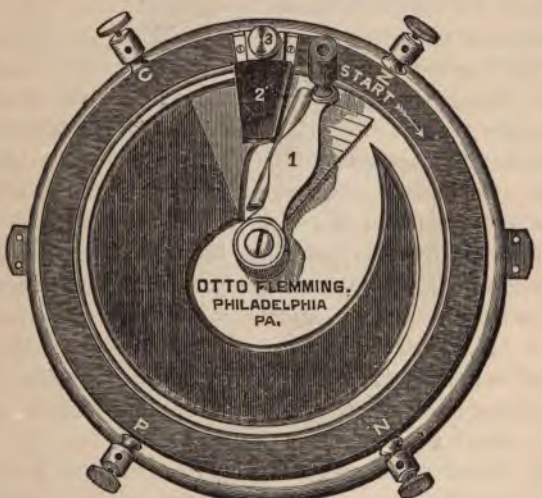

FIG. 3.—AUTHOR'S CURRENT CONTROLLER.

broken. Moving it slightly in the direction of the arrow, it soon touches the graphite mark and permits the least amount of current to pass through, since the current must pass through the whole length of the graphite,—a poorly-conducting medium. As the crank is slowly brought down from the point of rest and up the other side, there is a progressive, gradual increase of current,

until, finally, the nickel-plated area at the left of the rubber bridge is reached, when the whole power of the battery is turned on, there being no resistance remaining in the controller. A reverse action turns the current off. If this motion is made slowly the increase and decrease is exceedingly gradual, and the meter-needle points constantly to the exact current strength of the moment without oscillation.

Special attention should be paid to the following points in using the instrument:—

1. Always place the turning crank on the bare porcelain, as shown in the figure, before applying the electrodes to the patient, so as to be sure that the full resistance is interposed; otherwise an unpleasant or even dangerous shock to the patient might result.

2. After the electrodes are in place, turn the crank down and toward the broader graphite *slowly* until the meter shows the desired current strength.

3. If using an incandescent current, never bring the metallic part of the cords or electrodes together unless the crank is on the thinnest part of the graphite.

4. Keep the apparatus free from dust.

5. Renew the graphite covering on the porcelain plate as often as marks of wear are visible by rubbing graphite over the circumscribed area from a *very soft pencil.* If the current is too strong at the very point of the graphite, rub some off and re-coat it more lightly.

This instrument is chiefly valuable in enabling us to use an incandescent electric light current for all strengths of medical galvanic work. The principal advantages in using it with a battery of cells, instead

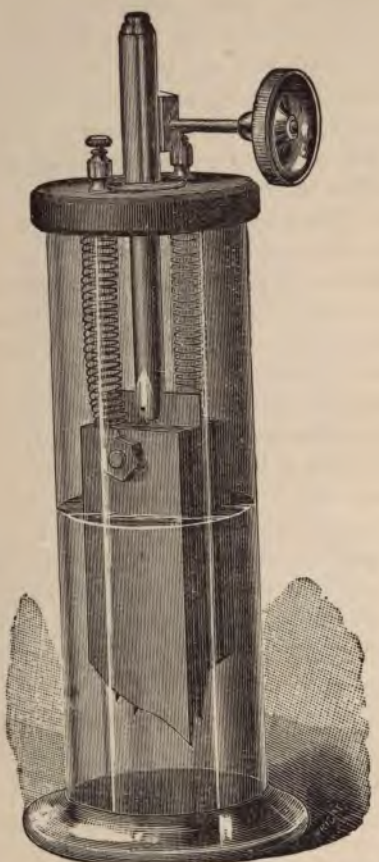

FIG. 4.—BAILEY CURRENT CONTROLLER.

of the older cell selector still advised by most writers, are: its simplicity, the greater certainty of avoiding shock, the even wear of the cells, the saving of the exhaustion of each cell as it is short-circuited by the selector crank in turning on or off, and the possibility of mounting the terminal apparatus on a movable table which may be attached to the circuit at any point in a room or house where two wires may be carried to binding posts. This movability of apparatus is impossible when a selector is used.

Previous to the perfection of this graphite controller there was nothing equal to the Bailey Current Controller (Fig. 4), made by the Law Telephone Company, of New York. This was made originally to control the strength of the currents used in telephone exchanges, and is a development of the water tube and rod, the rod being replaced by four broad carbon plates, giving immense surface contact with the water when fully immersed. The plates taper to points below, and by means of a ratchet and pinion may be gradually immersed into the water or raised out of it, giving an exceedingly wide range of resistances, and enabling the current to be varied without the possibility of shock from zero to any desired number of milliampères.

In use it requires watching to prevent the mechanism becoming too loose, permitting the plates to descend of their own weight. The main objection to it is its unwieldy shape, and the fact that it leaves a certain amount of resistance in the circuit.

The Meter.—With light currents applied to skin surfaces, where the sensitiveness of the patient is added to the watchfulness of the operator, there may be ample

excuse for occasionally neglecting to use a meter and depending on the number of cells in circuit; but when we have an insensitive mucous membrane, as in the vaginal, uterine and urethral tracts, situated so as to make it impossible to watch effects, it is simply criminal to use a galvanic current without adequate means of knowing the amount actually passing through the pa-

FIG. 5.—FLEMMING'S MILLIAMPÈRE METER.

tient. Such neglect cannot be too strongly condemned. Milliampère meters are at present quite cheap, and should be ordered with every battery. They should register from one milliampère to six or eight hundred. Those made in this country by Flemming and Waite and Bartlett make it unnecessary to send abroad for foreign instruments; in fact, the American instruments

have proven superior to the imported ones in the author's experience.

The directions for using Flemming's meter (Fig. 5) are as follow: When the meter is being transported the needle should be arrested by turning the knob, K, until it no longer moves. When about to use it release the needle by a reverse movement of the knob, when it will be seen to swing freely on its pivots. If the needle does not settle at the 0 of the scale when it comes to rest, it is evidence of the displacing power of the earth's magnetism at that particular spot, and should be remedied by raising or lowering the case by means of the adjusting screw, S, until the index is exactly at zero. The scale on this instrument is divided into ten units from zero in either direction. When the double switch, M, at the base of the instrument points to the figure 1 in front of it, the figures of the scale indicate a milliampère each. If this switch points to 10 the scale reading is to be multiplied ten times. If it points to 100 the scale is to be multiplied one hundred times. Thus, if the switch points to 1 and the needle indicates 3 on the scale, there is a current of three milliampères in the circuit; if the switch points to 10 and the needle to 3 there are thirty milliampères; if the switch points to 100 and the needle to 3 there are three hundred milliampères. When using currents of less than ten milliampères, therefore, the switch, M, should point to 1; when less than one hundred are to be used it should point to 10, and when over one hundred it should point to 100. Before turning on the current always be sure that the needle is free.

As formerly made, these meters presented a resist-

ance of one hundred ohms within themselves, greatly interfering with the full use of a small number of cells,

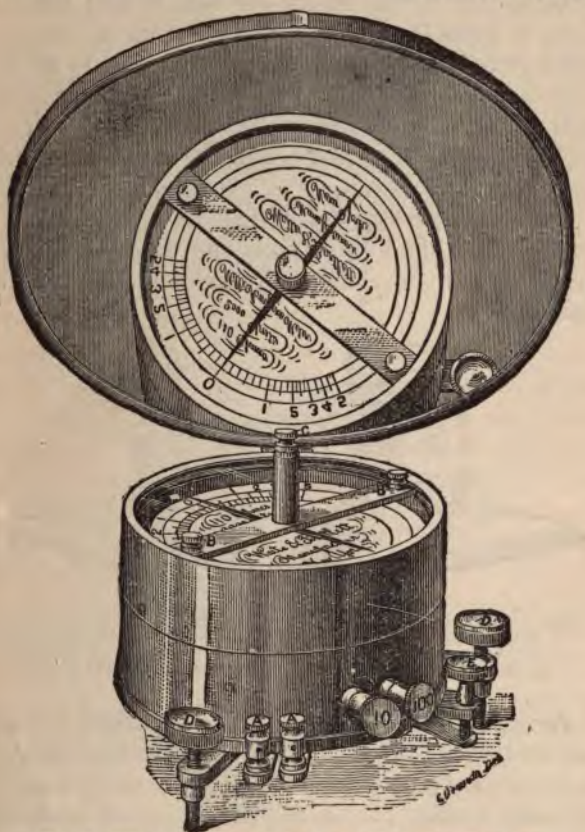

FIG. 6.—WAITE & BARTLETT'S MILLIAMPÈRE METER.

but at my solicitation the resistance of the 10 shunt has been lessened to ten ohms and that of the 100 shunt to

one ohm, the resistance of the direct reading or 1 position remaining one hundred ohms.

Of the horizontal meters the best is that made by Waite & Bartlett (Fig. 6). This instrument is supplied with a reflecting mirror, which adds greatly to the ease of reading a horizontal meter at a slight distance, and is made either with or without shunt. It should be orientated and leveled before use, and the needle lifted from the bearing after use.

No milliampère meter, particularly of the horizontal variety, should be within two feet of magnetic bodies—pieces of iron or steel—or other inductive influence when in use.

FIG. 7.—COMPLETE ELECTRO-GYNECOLOGICAL APPARATUS FOR BOTH CURRENTS. (Author's design.).—The faradic apparatus may be removed from the table when delicate galvanic measurements are made. Designed for incandescent current or cells.

Arrangement of Circuit.—In use, the meter and current controller are inserted into the circuit by including them one after the other, between the last carbon and its respective binding post, as follows: From the last carbon carry a wire to one terminal on the controller; connect the other terminal on the controller with a binding screw on the meter; and, finally, carry a wire from the other

binding screw on the meter to the positive binding post. The two instruments may be arranged on a single base-board (Fig. 7) or on a table, as shown in Fig. 8, which

FIG. 8.—BEDSIDE GALVANIC TABLE.—For use with supply wires from an incandescent plant or permanent battery. Connection with the supply wires is made by a double plug and socket, or by two binding posts.

is an illustration of a movable ward galvanic table, designed by the author for bedside use in the Infirmary for Nervous Diseases and in his private hospital. Fig. 10

illustrates a more elaborate stationary arrrangement of the same switch-board elements combined with a faradic apparatus, as constructed by Otto Flemming for the operating-room of the author's private hospital.

Use of the Edison Incandescent Electric Light Current in Medical Work.—This current will be found in every way well adapted for medical use, and should be preferred to that furnished by the ordinary battery of cells whenever it is possible to obtain it during the hours convenient for work. By its use the possible annoyances and inconveniences of a battery are entirely avoided, and a current capable of variation to any strength from a fraction of a milliampère to a thousand milliampères is ever at hand. The whole strength of the current is supplied by the two supply wires, and its medical use demands, of course, some means to diminish it at will. This is thoroughly accomplished by the controller and meter described in these pages, their use rendering it just as safe as the current from any kind of battery. They are inserted in the circuit as follows: An ordinary lamp socket, properly connected with the circuit, is attached to the wall at a convenient point, and the apparatus is connected with a long, double cord attached to its plug. Within the plug a three-light safety-fuse is placed. If a complete apparatus is used the polarity of the cords is tested, and they are permanently attached as the cells would be, the positive to P, and the negative to N.

If a separate meter and controller are used, connect one cord (Fig. 9) directly with one of the binding posts for electrodes; the other cord is connected with one binding post on the controller; from the other binding

post on the controller a wire is led to one binding post on the meter; and from the other binding post on the meter a wire is led to the remaining electrode binding post. All that is to be done now is to test the polarity of each terminal binding post and mark it accordingly. The + mark is usually used to indicate the positive pole, and the — mark the negative. For method of testing, see page 28. The controller and meter should

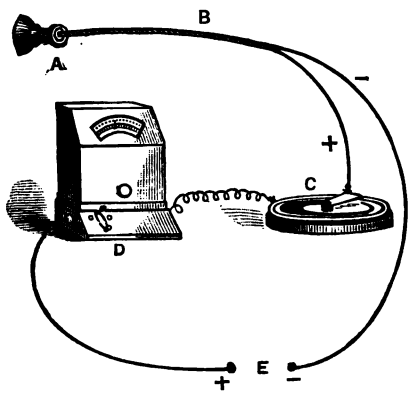

FIG. 9.—DIAGRAM OF CIRCUIT ARRANGEMENT FOR USING INCANDESCENT CURRENT.—A, lamp-socket with plug inserted; B, double conductor; C, controller; D, meter; E, electrode binding posts.

be kept permanently in the circuit in this way,—especially the former,—more as a precaution against injury to the instruments by "short-circuiting" than from fear of injuring the patient, as the full strength of this circuit can force no more current *through the body* than can the full strength of any ordinary medical battery of sixty or seventy cells. To avoid accidentally burning out the meter, the controller should always be kept with

the crank to the right of the bridge when not in actual use, and the brass parts of the electrodes should never otherwise be brought together.

The Edison circuit, direct from the dynamo, which the author uses daily in office practice, has a usual electro-motive force of about one hundred and ten volts, and is therefore equal in force to about seventy-three good Law or Leclanché cells. The internal resistance is practically *nil*, rendering it equally available for use with the galvano-cautery knife as in medical work, provided proper resistances are inserted in each case.* The only disadvantage is the necessity of *keeping* some resistance in circuit to prevent "short-circuiting" and consequent injury to the meter. The current from a storage battery used for lighting purposes is also available for medical work if the voltage is sufficient (fifty to one hundred volts). No *direct* and *continuous* incandescent current of these volt powers is in any way more dangerous than a cell battery of the same volt power, but it is important for physicians to note that there are a number of incandescent house-lighting plants established in various parts of the country, notably those operated under the Westinghouse patents, in which alternating currents of higher pressure are used. These currents, besides having no definite polarity, are closely allied to high-pressure currents in their production, and are dangerous.

Before arranging to use an incandescent current from the street for medical purposes, an assurance should

* The graphite controller should not be used to heat the galvano-cautery knife. Flemming now furnishes a carbon-rod controller which will regulate the Edison current for this purpose.

be obtained from the producing company that any interruptions or reversals of the current in the station are impossible during working hours, and that there is no danger of crosses with arc-light currents.

Arc-light currents (which have a pressure of several thousand volts) are of course highly dangerous, and totally inadmissible for this purpose.

Cutaneous Electrodes.—The essentials for either experimental or therapeutic work are now complete, if to the above list be added appropriate electrodes and conducting cords. For the experimental work we should be supplied with at least one each of the two sizes of cutaneous electrodes required as dispersing poles in therapeutic work, as well as a pair of the ordinary disks with handles usually supplied with faradic batteries, and a fine-pointed electrode (the latter readily improvised from a stiff wire). The larger dispersing electrode must be of a size to completely cover the abdomen,—viz., about nine by ten inches,—made of thin sheet-lead in order that it may be made to take any shape to fit the abdominal contour. The smaller one is most convenient when not larger than five by six inches, and may be made of either thin brass or lead. It is best covered with a layer or two of absorbent cotton,* the latter being unrolled and cut about an inch larger than the plate, and kept in place by fine spool-cotton loosely wrapped. The method of applying the absorbent cotton to the larger

* It is gratifying to note the wide-spread and general adoption of absorbent cotton as an electrode covering in place of what a writer has called "the filthy, current-absorbing sponge," since its use was first recommended by the author in communications to the *Medical News*, February 7 and December 26, 1885.

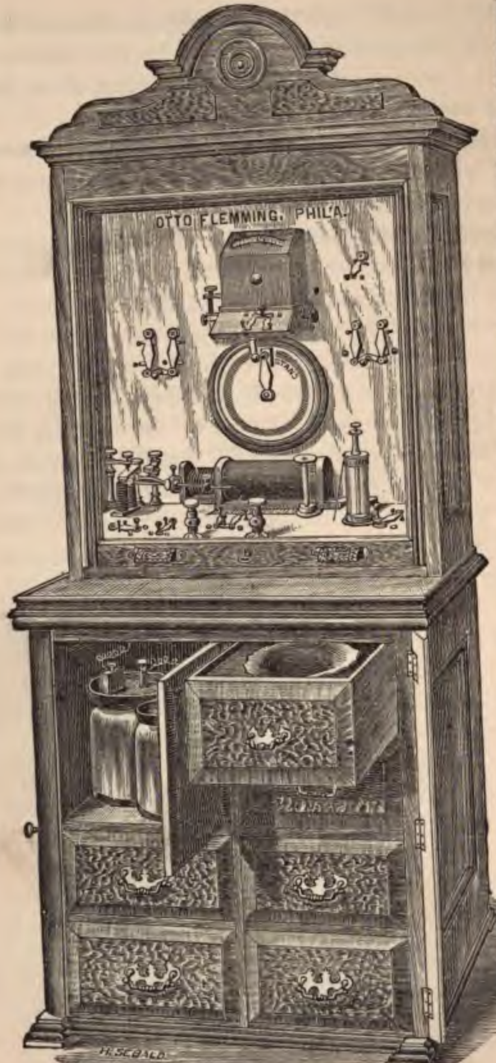

FIG. 10.—THE AUTHOR'S OFFICE CABINET.—This cabinet furnishes both currents, separate or combined. Permanent cells may be placed on shelves attached to the rear of the cabinet, and the whole mounted on rollers; but usually the larger size of cells are to be preferred, kept in a separate compartment. The original form of the graphite or pencil-mark controller is shown in the centre of the switch-board.

electrode is described in Chapter V. The disks and point are readily wrapped with cotton at each using in the same way that an applicator is covered.

For therapeutic and surgical work a series of special electrodes and needles are required for use as active poles, in addition to this list of dispersing plates. They will be found described in the chapters devoted to each operation.

I have been particular to specify that a meter and current controller should accompany the battery, for the regular and invariable use of this combination not only permits of scientific and accurate work, but really simplifies the whole subject to the beginner. They may be said to be devices for relieving an operator from the burden of knowing anything of Ohm's law, or of making calculations of resistances and current strengths, although, of course, their practical value is far greater than this.

CHAPTER III.

EXPERIMENTS ILLUSTRATING THE PHYSICAL QUALITIES OF GALVANIC CURRENTS.

HAVING set up the battery or put it into operation, and connected the meter and controller in circuit, the conducting cords and electrodes may be attached to their binding posts in readiness for the first experiment.

To Test for Current.—(*Experiment 1.*) Set the controller for least current (in the graphite controller with the crank on the beginning of the pencil-mark to the right of the rubber button, and in the Bailey controller with the sponge-tips merely touching the water), and bring the brass parts of the electrodes together. The meter will show a deflection of more or less extent. If there is no deflection a break exists in some part of the circuit.

To Test the Power of the Battery and the Range of the Controller.—(*Experiment 2.*) Unite the poles directly by means of a conducting cord or wire, and note the gradual increase in the current as the crank is moved toward the broader graphite, or the carbon plates are slowly immersed into the water. This procedure is wasteful of battery power, but will show the total capacity of the battery through these resistances, if the meter registers high enough. With the incandescent current the increase should not be above the capacity of the meter.

To Test the Polarity of the Electrodes.—(*Experiment 3.*) If in doubt as to which is the negative

pole and which the positive pole of a galvanic battery, place the tips of the cords in a solution of potassium iodide. The compound will be electrolyzed, iodine appearing at the positive pole as a brownish cloud, and potassium at the negative pole. If the potassium iodide be dissolved in starch-water, the discoloration at the positive pole is blue instead of brown, the nascent iodine immediately uniting with the starch. A more quickly performed test than this is to ascertain which moist electrode produces greatest pain on suddenly making contact; that one will be the kathode, or miscalled negative pole.

Comparison of Metallic Contact with Moist Cotton to Cotton Conduction.—(*Experiment 4.*) *Having set the controller for a weak current*, note the number of milliampères in circuit when the brass surfaces of the two electrodes are brought together, and the number when the two wet surfaces of cotton or sponge are pressed together.

This will show the immensely greater conductivity of brass. As the current is not intended to go right back to the battery in this manner during ordinary work, it is called "short circuiting," and is wasteful of the battery power and dangerous to the delicacy of the meter.

Application of Dry Metallic Electrodes to Skin compared with that of Wet Electrodes.—(*Experiment 5.*) Experiment now with the dry metallic surfaces of the electrodes pressed down upon dry-skin surfaces. Little or no current will be shown by the meter if the skin is free from moisture, even with the controller set for full strength. Substitute wet cotton-covered electrodes for

the dry ones, and a current will be shown both by the sensations and the meter.

The current passes with exceeding ease from metal to metal when in contact, either dry or wet; but passes from dry metal to the body with difficulty. This is because the cuticle is practically a non-conductor; not until the air-spaces of its horny layers are filled with water, which is a reasonably good conductor, will it permit the current to penetrate to the moister tissues below, and even then the bulk of the current passes through the sweat-ducts and any congested or abraded spots. Electrode coverings are therefore designed merely to hold a layer of water between the metallic surface and the skin, acting as a conducting joint.

In making the experiment just detailed with dry metallic points instead of a flat surface, an intense burning sensation will soon develop if the full number of cells are used and the points well pressed down. This burning coincides with the appearance of some current in the circuit, as shown by the meter; but the number of milliampères by no means corresponds with the intensity of the burning; very little current passes, in fact, when the pain is greatest. This pain of the "galvanic brush" is usually described as due to the concentrated action of the minute current quantities upon the most superficial and sensitive nerve filaments; but doubtless the real reason is the microscopic spark-leaps through the cuticle incidental to this mode of current transmission.

Effect Produced on the Current Volume by Salt Water on the Electrodes.—(*Experiment 6.*) Set the controller at a given place and leave it there (or use

the full strength of a certain number of cells), and note the number of milliampères passing through the hand when both wet electrodes are pressed upon opposite sides; leaving the battery strength undisturbed, remove the electrodes and saturate them with salt water. When they are replaced, a considerable increase in the number of milliampères passing through the hand will be found. The sensations will be still more acutely increased.

Saturated salt water is about three thousand times a better conductor than distilled water; hence the use of salted water on electrodes increases the current by lessening the resistance offered by the "conducting joint" at the points of entrance into and egress from the body. It is of great service when the battery power is deficient or accidentally low; but its constant use is inadvisable, owing to the disproportionate increase of pain produced by it and the bad effect upon the electrodes, which are quickly oxidized. The excess of pain is doubtless due to the irritant effects of the products of the decomposed chloride of sodium.

Effect upon the Current of Different-sized Electrodes.—(*Experiment 7.*) Note the number of milliampères passing through a part of the body from the full strength of fifteen cells,—(1) when two small electrodes are used; (2) when two medium ones are used; (3) when two large ones are used,—care being observed to place them in the same spots and press their whole surface in contact.

If it is more convenient to use all the cells in the way advised generally in this work, instead of using the full strength of only fifteen, it may be done by simply setting the controller for a comfortable current with the small

electrodes, and leaving it untouched in the subsequent steps of the experiment.

The increase of current when the larger electrodes are used is exceedingly striking. The cuticle, as has been explained, is the chief obstacle to the current; and from a given number of cells but a certain quantity can be forced through each square inch of its surface. The more square inches are included in the conducting surface, therefore, the more current will go through from the given number of cells; but there will be no increase in (and possibly a slight diminution of) the number of milliampères passing through the original square inch of skin, unless the number of cells is increased or the resistance of the controller lessened. The use of broad electrodes is indicated, therefore, whenever we wish to introduce a large current into the body with a minimum of pain, and without a special concentration at the points of entry. It is the only way to affect deep structures by percutaneous transmission without excessive pain, and for such purposes both electrodes are large. In gynecological work, where the effect of a single "active" pole is alone desired, the other "indifferent" pole is made sufficiently large to secure easy penetration without such local action.

Comparison of the Effect of the Same Current Strength when Concentrated and Diffused.—(*Experiment 8.*) Connect the body with the positive pole of the battery by means of a large moistened electrode on its surface. This will form the indifferent pole. Select (1) an equally large moistened electrode for the active pole; place it on another part of the body; connect it with the negative terminal of the battery, and bring

the current up to, say, eight milliampères, as shown in the meter. Note the slight pain produced. (2) Exchange the large active pole for a medium-sized one, moistened of course, and bring the current up to the eight milliampères. The pain will be increased, owing to the concentrated action of the same number of milliampères. (3) Use next a fine point as active pole, well covered with moist cotton, and again bring up the current to eight milliampères. The pain is quite decided.

As the size of the active pole is diminished, the current being kept the same by adjusting the controller, there is an increase in the intensity of the pain corresponding to the increased density at this spot. The indifferent pole is left large in this experiment, as in so many gynecological operations, because it combines a slight resistance to the current with the least local pain. The experiment illustrates admirably the axiom that more force is required to get the same sized current through a small place than through a large one,—a principle that applies self-evidently to most things.

Increase of pain accompanies with great certainty an increasing concentration of a given number of milliampères on the skin surface; but it should not be forgotten that this is because of the peculiar sensibility with which the body-sheath is endowed. Beneath it and in the interior of less sensitive cavities there is no such admonition to guide us; hence the use of a meter becomes more imperative in the latter situations, for the current is just as active whether pain is felt or not. It is only at and near the junction of mucous membrane with the skin surface, such as the lips, vulva, etc., that great sensitiveness to currents exists; and here it is even more

sensitive than on the skin surface, in accordance with a fuller endowment of sensitive nerve-filaments.

Differing Resistances of Skin Surfaces.—(*Experiment 9.*) The differences in the resistance offered by the skin of various parts of the body, and of different persons, is readily shown by the effect on the meter at each position, the battery and controller being left undisturbed. The face, inner surface of the limbs, etc., will show more current (presenting less resistance); while the back and outer surfaces of the limbs will show less current (presenting more resistance), etc.

That these differences depend almost entirely on varying thicknesses of cuticle is proven by the showing of more current with the poles on distant but thin spots than when alongside of each other on thicker cuticle. The difference between corresponding parts of the skin of different individuals is also at times considerable, especially when a clear-skinned blonde and pallid brunette are compared.

Comparison of the Resistance of Skin and Mucous Membrane.—(*Experiment 10.*) Connect but a small number of cells, say fifteen, with the meter and controller, in order that the full strength of that number of cells may be used. Having put the indifferent pole on the abdomen or back, cover an insulated-stemmed vaginal electrode with absorbent cotton, wet it, and direct the subject of the experiment to hold it between the bare arm and chest in such a manner that the whole conducting surface is in contact, as it would be in the vagina. Turn the current on gradually now to its full extent by means of the controller, and note the number of milliampères. Reverse the controller until there is

no current, and introduce the electrode into the vagina. The current may then be again increased by the controller to its full capacity, and the number of milliampères noted in this situation.

A marked increase in the milliampères will be noted in the vagino-abdominal circuit over the merely percutaneous one, on account of the lessened resistance encountered at the active pole when placed in contact with mucous membrane.

The actual performance of these and similar experiments is unequalled in its teaching power. Besides familiarizing one with many details essential to successful work with the continuous current,—such as the necessity for always using a meter; the possibility of avoiding shock, even with powerful currents; the advantage of ample battery force held in easy check by a controller; and the wisdom of using large or small electrodes as we wish non-local or local effects,—it will show that the practice of electro-therapeutics, while relieved of many unnecessary and obsolete physical theories, may still remain free from the formidable task imposed by at least one recent writer, Engelmann,* who recommends that the resistance of the tissues be calculated and recorded in the history of each case. As well might he say that we should measure the darkness in a room rather than the light produced in the effort to dispel it; and the measurement of darkness under the circumstances would be even more useful, for we can readily assume that any two closed rooms are equally dark;

* "The Use of Electricity in Gynecological Practice" (reprint from "Gynecological Transactions"), page 146.

while no two human bodies present exactly the same resistance, nor can electrodes be put on or within them twice under exactly similar conditions. Exactness of record is amply attained if the number of milliampères is given, together with the name and dimensions of the active pole and the duration of the application.

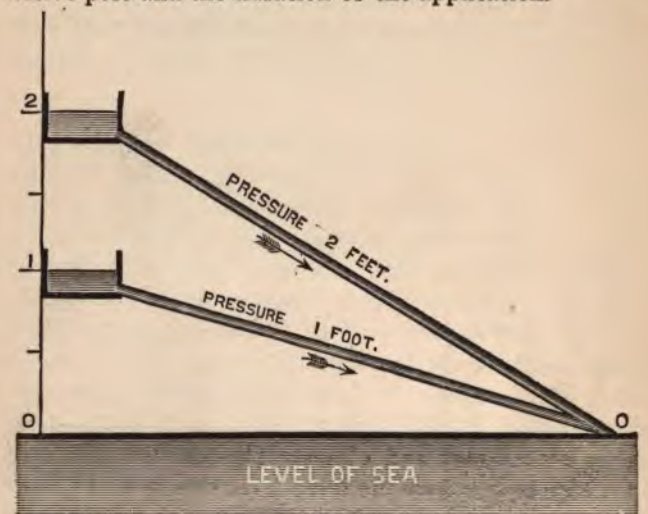

FIG. 11.—DIAGRAMMATIC REPRESENTATION OF THE CAUSE OF FLOW IN HYDRAULIC CURRENTS.—The pressure, measured by a vertical scale of feet, is due to the elevation of the source or reservoir. The amount of water delivered will depend on the calibre of the pipe as well as on the height of this pressure.

Such experiments will also show the thoughtful student that a galvanic battery, or any other source of ampères or milliampères of current, is a reservoir of this peculiar form of energy, and in giving it out obeys laws singularly analogous to those of the force stored in a reservoir of water. If we examine a stream of water issuing

from a reservoir (Fig. 11), we will find two qualities in it which it will be somewhat difficult to separate in the mind,—pressure and volume. The former is the force by which water transports itself, and depends on the height of the water in the reservoir. It is the same in all pipes issuing from it, whether large or small. The volume of water carried by a pipe, on the other hand, depends on the size and length as well as on the pressure.

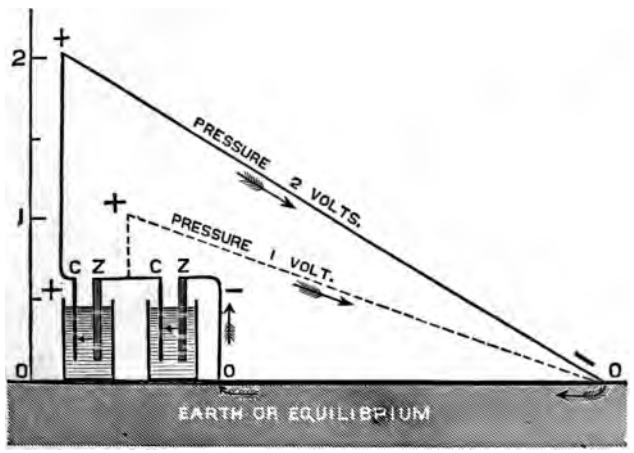

FIG. 12.—DIAGRAMMATIC REPRESENTATION OF THE CAUSE OF FLOW IN ELECTRIC CURRENTS.—The pressure (or electro-motive force), measured by a scale of volts, is due to the elevation of the electric level of the positive end of the conductor by the particular generator in use. The amount of current delivered will depend on the size and conductivity of the wire as well as on the height of this pressure.

In electricity (Fig. 12), the peculiar force by which it transports itself is called electro-motive force; and it likewise is independent of the size of the wire or excellence of the conductor. It is measured in volts. In galvanic batteries, the number of volts of this "pressure"

depends on the number and volt power of the cells when serially arranged (placed one after another).

The "volume" of the electric current is equally analogous to that of the water current, for it depends jointly on the height of the pressure (the number of the volts) and the size of the conductor (the diameter and length of a wire if a metal, and the conductivity, breadth, etc., if a living compound). It is this result of the pressure through the resistance—this volume of the current—that is indicated by a meter. For medical purposes it is measured in milliampères, or thousandths of the commercial ampère,—a unit adopted in 1881 for the measurement of current volume.*

The Milliampère.—It follows from these facts that the milliampère is the medical unit of electricity itself in transit, just as the gallon per minute is the unit of a water current.

It is taken as the medical unit because the ampère, of which it is the one-thousandth part, is too large. The milliampère represents the chemical-cauterant, electrolytic and catalytic power of electricity, being, in short, a unit for the measurement of current bulk, or volume. As compared with the currents used in the industrial arts, even those employed in ringing bells, the strongest medical currents are weak, the current strength used in the Morse system of telegraphy being nearest. The great value of the milliampère meter is that, *when placed in circuit with the patient*, it will always show the exact current bulk or strength which succeeds in overcoming the resistance, and actually circulates through the body, thus avoiding the need of calculations.

*For a fuller consideration of the law of Ohm, and its graphic representation, see Appendix.

The Volt.—This unit, unlike the milliampère, is not a measure of real current strength, but merely of the *pressure* at which the current is delivered. Pressure, potential, and electro-motive force are all terms meaning practically the same thing, and are used to indicate that quality of a current which enables it to overcome resistance. The current from one Law or Leclanché cell has a pressure of one and a half volts. If two such cells are united "in series,"—that is, the zinc of one with the carbon of the other, as in Fig. 12,—we obtain the pressure of both cells in the circuit, or three volts.* Additional cells add additional pressure. A current from ten zinc-carbon cells would therefore possess a pressure of fifteen volts, and a current from fifty cells seventy-five volts. The only reason why the percutaneous medical use of electricity requires the current to possess a voltage varying from twenty to a hundred is that the poorly conducting skin may be pierced and a sufficient number of milliampères supplied, for with a continuous current it matters not whether a given number of milliampères obtained by the use of a controller has a pressure of ten or a hundred volts. With uninterrupted currents the additional pressure is apt to be more painful at the moment of interruption. The conductibility of the body is such that a continuous current with a pressure over six or seven hundred volts becomes dangerous if allowed to pass through it, as such a pressure may transmit from two hundred to twenty-five hundred milliampères between the points of body-contact, in accordance

* Each cell in Fig. 12 is represented with a pressure of exactly one volt for convenience of illustration. This is about the electro-motive force of all zinc-copper cells, the Daniell being placed at 1.079 volts.

with the moisture of the surface; and with the good contacts of medical work a lower pressure may do harm. The main toxic action is that of shock from sudden polarization of the body. As alternating currents create a rapid series of such polarizations and reversals, a still lower pressure is toxic.

The Ohm.—The ohm is the unit of measurement of the resistance that a current meets in a circuit. A piece of copper wire one-twentieth inch in diameter and two hundred and fifty feet long presents almost exactly one ohm resistance. The broader and shorter the wire, the less resistance it will present, and *vice versâ*. But, independently of length and thickness, all metals present far less *specific* resistance than the human body, as two layers of dry cuticle may interpose a resistance of from three thousand to ten thousand ohms. By making these cuticular conducting surfaces very broad and thoroughly moistening them, the resistance may, however, be reduced to as little as two hundred ohms, and even lower.

CHAPTER IV.

ACTION OF CONCENTRATED MILLIAMPÈRE CURRENTS ON ORGANIZED TISSUES.

GYNECOLOGICAL applications of electricity consist so largely in the continuous, concentrated action of one or the other pole of a current strong enough to produce more or less destruction of tissue, that the exact nature of this destructive process invites close attention. A careful naked-eye observation of the phenomena when a strong current is flowing is certainly both instructive and impressive, as well as decidedly conducive to the future welfare of the observer's patients. An experiment with fresh butchers' meat will give a very good illustration of the chemical part of these phenomena as they occur within the living body.

Chemical Effects at Each Pole.—(*Experiment 11.*) Procure a half-pound of beef-muscle; insert into it two ordinary steel needles, one connected with the positive pole and the other with the negative pole of a good battery, and pass through the meat from one hundred to two hundred milliampères for two minutes.

A sort of hissing or frying noise will be heard. This is seen to be caused by the rapid production and escape of small bubbles (of hydrogen gas) from the track of the negative needle. The positive needle will cause no appreciable production of gas, but will immediately be found to be so firmly fixed in the tissues as to be withdrawable with difficulty.

On cutting down alongside the negative needle it is

found to be practically surrounded by a cavity containing liquids and bubbles of hydrogen gas. The muscular tissue has been destroyed wherever in contact with the needle, the edges of the cavity showing it softened, infiltrated, and of a darker color. The needle remains as bright as ever.

The positive needle, if left in place and cut down upon, shows itself greatly rusted and corroded, inclosed firmly in a grayish eschar, colored darker in places by the dissolved iron of the needle.

If the positive needle be of brass, copper, nickel, aluminum, or any of the other baser metals, it is corroded with equal rapidity, the tissues being stained by the particular metallic salts formed for some distance from the needle. On using a gold or especially a platinum needle for the positive pole, on the contrary, it is found to be practically unattacked by the nascent oxygen and acids. The tissues about the needle show now the uncomplicated picture of a positive electrolysis, viz., the characteristic hardening and searing of an acid application. A slight cavity forms about the needle, though not so large as that about the negative needle, filled with bubbles of oxygen gas which has failed to unite with the platinum, and the non-corrodible positive needle is therefore not firmly fixed in the tissues, as would happen with a baser metal. It is evident, therefore, that *whenever the active pole of a strong, concentrated current is positive, it should consist of either platinum, gold, or carbon*, as otherwise the electrode surface is destroyed and the tissues infiltrated with a foreign metallic oxide.

The negative needle remains clean, whatever the metal of which it is composed or the strength of the current.

According to Inglis Parsons,* after the passage of two hundred milliampères through a recently-removed fibroid for one and a half hours, "that portion of it acted on by the current cut quite hard and gristly as compared with the rest. This change was also perfectly apparent to the touch. On making some fresh sections and examining them under the microscope, I found that of the portion in immediate contiguity to the needle everything had disappeared except the fibrous tissue, and this result was obtained at both the negative and positive poles."

Reverting again to the disintegrated cavities in the meat, produced by the negative and positive poles of a strong current (the positive pole having been non-corrodible), we can easily prove that the froth at the negative is alkaline, and that at the positive acid, by placing a drop of litmus solution upon each and allowing the current to continue a few moments. The blue color of the solution is unchanged at the negative pole, but is quickly reddened at the positive. By changing the character of the pole back and forth while still *in situ*, several such changes of color can be produced. The peculiarities of the disintegrating action of each pole are clearly due to the nascent alkalies of one and the nascent acids of the other. At the negative pole we have the soft liquefaction and infiltrated edges of an alkaline caustic; at the positive pole the hardened, coagulated eschar of an acid caustic.

Electro-Chemical Reasons for Using the Negative Pole.—It is evident from these appearances that whenever destruction of tissue is desired the negative pole

* *British Gyn. Journ.*, May, 1888, p. 78.

and its soft liquefaction is indicated, and therapeutic experience seems to confirm the view that the secondary effect of destructive electrolysis—absorption—is more extensive after the negative application.

Electro-Chemical Reasons for Using the Positive Pole.—From similar considerations, the use of the concentrated positive pole with strong currents is almost entirely limited to two objects in gynecological work, namely, the control of intra-uterine hemorrhage, which it accomplishes by sealing up the bleeding orifices by its characteristic coagulation, and the production of a patulous canal, as for the relief of stenosis of the os or cervix.

Extent of Destruction at the Poles.—As to the extent of the destruction produced by a current,—a question of great interest in the electrolysis of tumors and other structures beyond the range of vision,—I have made the rough estimate that two hundred milliampères, concentrated at the half-inch exposed end of a negative needle, will destroy an area of this length and a quarter of an inch in diameter in the muscular tissue of the cadaver, if passed through for two minutes. It is more than probable that living muscle is acted upon to exactly the same extent, an equal destruction occurring in either case with the same number of milliampères, duration and concentration of the application; although more force is required to get the same current through the drier, dead muscle. This difference of resistance does not need to be considered, of course, when a current controller is used, as it matters nothing what the cell power may be if the milliampère readings are made to correspond. The amount of destruction produced by

the same number of milliampères in different tissues varies, though, and it may be said to depend largely on the aqueous contents of the tissue, for the cavities produced in the experiments on meat were caused to a large extent by the destruction of water. Less decomposition will be attained by the same current in a fibroma than in a striated muscle for this reason, and the disintegration depends more largely on the cauterizing effects of the liberated chemicals.*

Surgical Electro-Puncture.—The practical work of electrolysis in gynecology differs from the experiments just described, in that but one pole is permitted to be sufficiently concentrated to produce such results; the other pole, consisting of a large dispersing electrode, being placed, as properly advised by Apostoli and Engelmann, on the nearest convenient surface. This active pole, in the shape of a strong, spear-headed needle, generally has its conducting surface still further contracted by being insulated to within a half-inch of the point, enabling the operator to confine the work strictly to the neoplasm itself. The details of this operation are given in Chapter VI.

Galvano-Chemical Cauterization.—If electrolytic destruction of tissue has been produced by an active pole merely placed in contact with a mucous surface, it is called by Apostoli a *cauterization*, and this designation will not readily confound it with the entirely different cauterization produced by the heat of a galvano-cautery

* In a recent experiment on a fibroid, kindly placed at my disposal by Prof. H. A. Kelly, the cavities produced by two hundred milliampères in two minutes were fully as great as those described in meat.

knife, if the polar nature of the application is always stated as it should be,—whether a positive or a negative cauterization. This electrolytic cauterization with a single pole does not differ in any respect from that of electro-puncture, being found only when a strong current is concentrated in its passage through a mucous membrane by the small area of the conducting surface of an electrode, or when a weaker current is unduly prolonged. It is illustrated by slightly varying experiment 11. Instead of needles use two blunt metallic surfaces merely pressed into good contact with the meat. The same phenomena will be observed with similar current strengths as in the puncture experiments, with the sole difference that the energy of the disintegration of surface will be lessened owing to greater electrode size, and consequently lessened concentration.

The need of a moist covering for the electrode, that is so important when we wish a current to penetrate through the skin, does not exist in a permucous application, for the mucous surface is always sufficiently moist to furnish a perfect conducting joint between the metallic surface and itself. Several recent writers have been led astray on this point, teaching that a cotton-covered electrode favored easy transmission of current to deeper structures in permucous as well as in percutaneous work, and that the bare metal alone was liable to produce cauterization of the mucous surface. In truth, there is no difference between either the local or distant action of a covered and an uncovered negative electrode in contact with moist mucous membrane *when the current strength and the extreme area of the conducting surface of the electrodes* remain the same.

The wrapping of a bare electrode of course increases its size, and hence lessens the concentration of a given number of milliampères; but if the experiment be tried of passing the same number of milliampères through a piece of meat in two different situations—once with bare poles and again with wire ends wrapped firmly with cotton until their total size is the same as the bare poles—it will be found that the electrolysis is exactly the same, except that the cotton about the positive pole will save the meat some staining if the pole is of baser metal. The electrolysis produced in either case is a mere matter of strength and concentration of current, and one can cauterize a surface just as effectively with a cotton-covered electrode as with a bare one of the same size. The only way to avoid local action when using a strong current is to disperse its force by increasing the surface of the active electrode; and in vaginal applications, at any rate, this is quite possible with moderately strong currents by the use of large oval or cylindrical conducting surfaces.

Polar and Interpolar Regions.—In performing experiments, and in all surgical punctures and cauterizations, it will be noticed that no visible change occurs in the meat or tissues except directly at each pole. This is because an electrolytic disintegration of animal tissue consists in a resolution of the organized compounds of which it is formed into their chemical constituents,—acids and bases,—the two classes of bodies being separated and conveyed to one or the other pole. The acids, oxygen, etc., appear at the positive pole, and the bases and hydrogen at the negative pole. An actual transfer of particles in both directions takes place through the

whole distance of tissue between the poles,* but the freed particles, singularly enough, appear only in the immediate neighborhood of the latter. These freed particles, being in the active condition known to chemists as *nascent*, immediately attack the tissues at the poles, and, if in overwhelming abundance, cause the peculiar destructive appearances described in the preceding paragraphs.

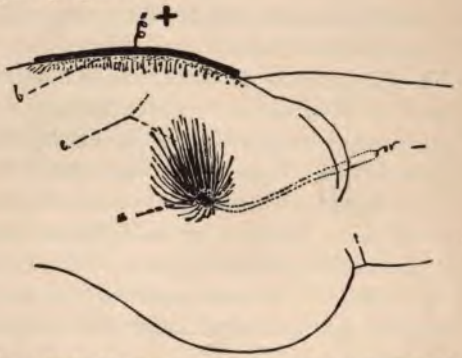

FIG. 13.—DIAGRAM OF THE POLAR AND INTERPOLAR REGIONS OF A CURRENT.—*a*, active polar region (negative in diagram); *b*, indifferent polar region (positive in diagram); *c*, interpolar region. The radiating curved lines in the interpolar region show the situations in this region where the current density is greatest; with the indifferent electrode on the back instead of the abdomen the denser area is more posterior.

The passage of a current of appreciable milliampère strength through the body presents, therefore, three distinct regions for therapeutic possibilities (Fig. 13),—two, restricted to the immediate vicinity of the electrodes, and called the "polar regions," and the third

* This may be experimentally proven by wetting the kathode with a solution of potassium iodide: after a varying period of application and strength of current, the free iodine will appear at the anode, having passed through the intervening part of the body.

extending along the lines of least resistance between the first two, and called the "interpolar region." Within the interpolar region the interstitial and cellular irritation incidental to the transmission of the current and of the particles that appear naked at the poles (cataphoresis) is the chief basis for therapeutic results, while in the polar regions the chemical action of these particles, as described above, is supplemented by another set of phenomena due to the behavior of nerves when under the influence of concentrated current at either pole. It is in the immediate vicinity of the poles, therefore, that the most direct therapeutic results are obtained, and the readiness with which electrodes may be brought in contact with diseased conditions within the pelvis is a most promising fact for the electro-therapeutics of gynecology; although, even in this class of diseases, the interpolar action of the current must frequently be depended upon.

It is hardly necessary to mention here that no attention is paid to the direction of the current, as such, by modern therapeutists, who look only to the polarity of the active electrode. The older terms "ascending" and "descending" were incorrect in view of the fact that a current spreads in all directions beneath each pole; and the reactions formerly attributed to one or the other direction are now known to be due to the polarity. Even within the interpolar region the direction of the current has no known significance at present.

Alteration of Nerve Irritability within each Polar Region.—(*Experiment 12.*) Attach two medium-sized electrodes of the same dimensions to the binding posts, place them (well wetted) on the skin over each peroneal

nerve just back of the head of the fibula, and increase the current to five or ten milliampères.

The burning pain under the negative electrode is in distinct contrast to the numb sensation under the positive. While pain is produced near the positive pole also, if the current be greatly increased in volume, it has been demonstrated by careful experiments that a nerve lying within the negative polar region has its normal excitability increased, and one lying within the positive polar region has its normal excitability diminished. These physiological facts were very early applied to the treatment of neuralgic conditions and the rule laid down that the positive pole was the best adapted for the relief of pain. I, myself, believe that this rule has been too hastily adopted. The polar modifications of a nerve are beyond dispute, but it is more than questionable whether the production of either anelectrotonus (positive polarization) or katelectrotonus (negative polarization) within a nerve can exert any influence upon the pathological conditions giving rise to pain; at any rate, my experience has been that the negative pole is even more effective for this purpose than the positive, for it has been so satisfactory as to make it useless to resort to the positive pole with the incorrodible electrode then necessary. The efficiency of the negative pole in the relief of pain might be ascribed by some to the after-effects of electrotonus, as ascertained by Waller and De Watteville,* who showed that sedation followed the excitement of negative polarization after the discontinuance of the current, and *vice versâ* with positive polarization; but, to my mind, the relief of pain is due rather to the influence of

*"Philosophical Transactions," 1882, p. 961.

the current of either pole on the physical molecular conditions of the nerve-trunk and on its circulation, as well as reflex impressions made on the centre, whence the pain so frequently emanates.

A practical matter to be considered when using a current to impress the sensory nerves of the pelvis is the wisdom of using as large a conducting surface for the vaginal electrode (when the application is vaginal) as convenient, in order that as much current—ten to thirty milliampères—may be used as is possible, without unnecessary cauterization of the mucous membrane. It should also be understood that the region of nerve polarization about an active pole is somewhat larger than the region of chemical decomposition, and that we can readily include within it any nerve or nerves within, say, three-quarters of an inch of the electrode, when using currents of twenty or thirty milliampères.

Current Action within the Interpolar Region.—Since it follows from the facts touched upon in the foregoing paragraphs that the chemically destructive action of a continuous current is limited to the close neighborhood of the electrodes, and the direct nerve-modifying action is also limited to a somewhat larger region in the same situation, the natural question arises: What can be therapeutically accomplished when the seat of disease is necessarily situated beyond the direct reach of the electrode? An answer drawn from both neurological and gynecological experience is that much can be accomplished; and this is doubtless due, in the first place, to the influence upon nutrition of the chemical interchanges that occur throughout the circuit, in the onward progress of the particles that appear free finally at the poles

(catalysis and cataphoresis), to the influence upon nutrition of the circulatory changes that result from vasomotor stimulation, and to the contractions produced in unstriated muscular tissue by heavy currents, even at a distance. These results of quiet current transmission are governed in magnitude at a given spot by the *density* of the current at that situation and by the *duration* of the application. The difficulty of carrying an effective density to a tumor, extravasation, or other morbid spot, situated at some distance from the active electrode, is indicated by a glance at Fig. 13, in which the spread of current is well represented by the direction and shading of the lines shown in the interpolar region. To accomplish much in the more distant parts of this region considerable milliampère strength must be employed; hence a delicate judgment is demanded in the selection of the size of the active pole to avoid cauterization on the one hand and too great a diffusion on the other.

Interrupted Galvanic Currents in Gynecology.—Galvanic interruptions, either rapidly or slowly produced, are rarely if ever used in direct pelvic applications, for the reason that they are far more productive of pain and shock than faradic currents and are in no wise more effective than the latter.* The avoidance of current variation, indeed, is a most important detail in the majority of applications of this sort, and it is for this reason that the author has insisted on the gradually increasing and decreasing method in this work.

A sudden current variation, either accidentally or

* This statement by no means applies to the neurological applications of electric currents.

intentionally produced in a galvanic current (or as naturally occurs at the beginning of each induction in the series of currents constituting the faradic current), should be understood as productive of effects that are essentially different from those of the continuous current. So far as we know at present the perturbation produced by it is limited entirely to an artificial stimulation of the functions of a nerve or muscle. No chemical changes whatever result from the variation as such, but merely the local stimulation, together with the centripetal and possible reflex effects of the sensory stimulus. The differing effects produced by a continuous current and by a current variation on a nerve may be studied by a slight addition to the details of experiment.

The Effect on Nerves of a Slowly Varied or Continuous Current Compared with that of a Sudden Current Variation.—(*Experiment 13.*) Proceed as in Exp. 12, noting that no pain or motion is produced in the distant parts of the nerve if the five or ten milliampères have been attained by a *gradual* increase from zero. With the current at this height remove now one of the electrodes and reapply it (or break and make the circuit by an interrupter),—a contraction will be produced in the muscles supplied by the motor fibres, and a sudden sensation in the areas supplied by the sensory fibres of the nerve.*

* If the nerves subjected to this experiment are not too deeply embedded in muscular or adipose tissue they exhibit very readily the normal polar reactions of motor nerves, so important in connection with the electro-diagnosis of paralytic conditions. It is readily seen that the greatest action is produced at the cathode at the closure of the circuit and at the anode at its opening; hence the formula: K. Cl. C''''., A. O. C'''., A. Cl. C''., K. O. C'.

Although exceedingly important in neurological work, such stimulations are generally to be avoided in gynecological applications, in which, if the current in use be heavy, they may be accompanied by exceedingly unpleasant shock, or even syncope.

CHAPTER V.

INTRA-UTERINE GALVANO-CHEMICAL CAUTERIZATION. (APOSTOLI'S OPERATION.)

THIS operation is the one most largely employed for the disintegration and reduction of fibroid tumors of the uterus, and it was while engaged in this work that Apostoli discovered its value in a number of other conditions associated with local alterations and hypertrophy of the uterine tissues. It is particularly valuable in the treatment of subacute and chronic endometritis, as elaborately pointed out by this author in a recent monograph.* Of its value in both classes of affections the author can bear the highest testimony, based upon results detailed elsewhere in this work. It consists essentially in a concentrated cauterization of the interior of the uterus by one pole of a heavy current (fifty to three hundred milliampères), administered from the bare surface of a sound-shaped intra-uterine electrode, and dispersed by a broad, indifferent electrode on the abdominal surface. The battery, meter, and current-controller used are described in Chapter II. Of the active and dispersing electrodes some special remarks are demanded.

The Intra-Uterine Electrode.—Apostoli and some operators in this country use a sound capable of being covered at will by a sheath, made of either glass or hard rubber, or, as specially commended by the former, of

*"On a New Treatment of Chronic Metritis," by Georges Apostoli. Translated by A. Laphthorn Smith.

celluloid, which is said to be less absorbent than the rubber (Fig. 14). These sheaths are extended backward into handles, through the whole of which the sound slides, and to which it may be rigidly connected at will by a screw. In my own practice I have found that this arrangement presented certain disadvantages. It is difficult to render the interior of the tube aseptic, and the best antiseptic—the flame of an alcohol lamp—cannot be applied to the exterior of the rubber and celluloid sheaths, owing to their inflammable nature. In most cases, moreover, the insulating cover should be extended beyond the bend of the sound, in order that the cervix may be protected from unnecessary cauterization and the current action confined to the interior of the corpus alone. This is impossible if the sheath is made of a rigid material, and, were it possible, the abrupt increase of calibre at the end of the cover would render the proper introduction of the sound impossible in many cases.

FIG. 14.—APOSTOLI'S INTRA-UTERINE ELECTRODE.

An exceedingly handy way to insulate a sound to any extent found desirable in a given case, after the proper curve has been given to it, and at the same time to thoroughly sterilize it, is to heat it to a considerable

temperature in the flame of an alcohol lamp, and melt upon it a sufficient coating of pure gum-shellac. This forms a smooth, highly-insulating covering that adheres tightly to the sound and shades off in thickness at the bare end so gradually as to readily admit a passage wherever desired. The fusibility of the shellac without burning is its greatest advantage over the best quality of sealing-wax, but the latter may, however, be substituted for it if the shellac is not readily obtained. In covering the hot sound at first the coating retained by it is too thin for safe reliance, and it should be made heavier after cooling by attaching additional quantities of melted gum-shellac to it, the whole being then reduced to a uniform thickness by gentle fusing.

This procedure is only adapted to an electrode closely following the form of a Simpson, or other rigid-shanked sound; and after the parts are once covered there should be no danger of the covered portion bending, as the material breaks easily, giving rise to leaks when in use. This disadvantage is, however, more apparent than real; for nothing is more trying in this work than an attempt to employ one of the flexible-shanked electrodes made by some manufacturers, who erroneously insist upon making the curved portion rigid and the shank flexible.

Fig. 15 represents the electrode usually employed by the author, for whom it was made by Flemming. It bears a general resemblance to the Simpson sound, with a hard-rubber handle of the usual flat shape for indicating its position *in uteri*, and the addition of a socket for the attachment of the conducting cord. The two and a half inches which may be left bare at the extremity

are made of platinum, to adapt it for use as a positive pole. The covering should be made to reach the platinum always, and it is generally best to protect the os and cervix by carrying it much farther up.

FIG. 15.—AUTHOR'S INTRA-UTERINE ELECTRODE.

FIG. 16.—AUTHOR'S ELASTIC ELECTRODE.

Before each operation, and after the desired curve has been imparted to the end, this electrode should be sterilized and any accidental breaks closed by a thorough

heating of the bare part and fusing of the first two or three inches of the covering.

For tortuous canals where the insulation need not be carried very high I have recently devised and largely used a flexible electrode (Fig. 16) made of coiled wire (platinum if it is to be used as a positive pole) with a solid tip. This is extremely pliant, and by its use cavities may be entered that would otherwise demand puncture. As it becomes very dirty from the nature of its construction it should (when made of brass) invariably be well boiled before use in each individual case, its elasticity and rubber insulation rendering the spirit-flame inadmissible. When made of platinum the flame may be used for the coil and absolute alcohol for the tube.

The Cutaneous or Dispersing Electrode.—The passage of heavy currents through the body in such a manner that all painful or truly destructive actions shall be confined to the one electrode was first achieved by Apostoli by an adherence to and extension of scientific rules already well known. The importance of a large surface in minimizing the local action on the skin at the indifferent electrode has been urged by German writers for years. Apostoli wisely made this indifferent electrode unusually large, in keeping with his increased currents, and placed it on the abdomen, where both least resistance and least skin sensitiveness are found. For a means of making a perfect contact between the metal of the electrode and the skin he has introduced the use of moistened potters' clay, specially worked over for each operation and spread upon a piece of tarlatan in a cake a third of an inch thick and about eight by ten inches in size. This is laid on the abdomen, tarlatan down, and

on the top of it a metal disk (three by four inches), which is connected by a conducting cord with one pole of the battery, is placed and gently pressed into good contact.

The objection to this form of dispersing electrode is the trouble and dirtiness of the clay, and the fact that the cold surface gives an unpleasant shock when first applied. It is evident that the water contained in the clay is the part of the compound that conducts the current, and that its only advantages are its size and the tendency to adhere closely to the skin. This quality of stickiness is, nevertheless, an important advantage when we are using strong currents (over one hundred milliampères), and I have found by experience that such currents may be passed through the clay with less danger of irritating the skin and causing an interference with the frequency of the operations than when any other form of conducting medium is used. For the easy preparation of the clay a wooden frame or trough of the size desired for the electrode (eight by ten inches) is used, having edges one-third of an inch high. Over this a piece of wet tarlatan is laid. The clay is then thoroughly incorporated with sufficient water, worked into proper consistence, and spread upon the tarlatan with a spatula or trowel, sufficient being placed on it to fill the space within the frame. By grasping the edges of the tarlatan the cake is now lifted from the frame and lowered, tarlatan down, on the abdominal surface, after which the trowel is passed over the surface, gently pressing it into good contact with the skin. On the top of the clay a plate is now laid, to which one conducting cord of the battery is securely attached. I have found

an advantage in having this plate consist of the thinnest commercial sheet-lead, and of a size only somewhat smaller than the clay cake. To make it adapt itself the more readily to the clay surface it is split from the periphery to near the centre in eight equidistant places. This large plate adheres so well to the clay and abdomen as to lessen greatly all risk of breaking contact by slight movements.

After one thorough moistening and working the clay may be kept ready for use by covering it up in a stone crock, such as is used by housekeepers for butter.* Ready-made clay pads as sold by instrument-makers do not possess the advantages of the specially-made article, and are in no way superior to well-soaped, wet, absorbent-cotton pads.

For currents less than one hundred milliampères, and even with stronger currents when the patient's skin is non-irritable, we may use instead of the clay a pad of absorbent cotton of the same size, made of at least three layers of the cotton, or even several folded towels, thoroughly wet with warm water. The lead plate is laid on the top of this pad in the same way as on the clay.

I have recently noticed that if the cotton pad is thoroughly *soaped* with glycerine-soap its power to conduct heavy currents through the skin painlessly is greatly increased—doubtless owing to better contact, saponification of the oil in the skin, and more thorough soaking of the cuticle. The burning produced by particularly heavy currents (three hundred to four hundred milliam-

* If a small quantity of glycerine is added to the clay mass, as first suggested by Lapthorn Smith, its affinity for moisture will aid greatly in keeping the clay soft and smooth.

pères) may be greatly lessened by having large dispersing surfaces on both abdomen and back, the patient lying upon the latter. Both cords attached to them are carried to the same binding post.

Dr. F. H. Martin, of Chicago, has recommended a dispersing electrode shaped somewhat like an inverted metallic basin. An animal membrane is stretched over the brim and the interior filled with warm water. It is laid with the membrane in contact with the abdomen when in use. If allowed to dry it is liable to get out of order and drench the patient's clothing.

Precautionary Details.—There are certain things which should be methodically attended to before each separate operation, to avoid the possibility of either a failure of its technical smoothness or a painful mishap to the patient.

Examination and Arrangement of Apparatus.—The operator should, first of all, be sure of the perfect working of his battery. If he has an incandescent circuit at command, or a well-connected Law or Leclanché battery, he need not trouble himself on this score. With a less perfect battery the strength and perfect working should be tested by joining the terminal poles directly, gradually turning the controller, and paying attention to the effect on the meter. If an acid battery be employed, all the cells should be put into action and tested in this way.

2. While testing the battery the freedom of motion of the meter-needle should be noted, and if it does not come back exactly to zero, the instrument should be leveled accordingly.

3. The test being satisfactory, *the controller should*

be reversed until the circuit is entirely broken, in readiness for the operation.

4. Examine the conducting cords to see if there is not a break somewhere. The one attached to the lead plate requires particular attention.

5. Determine upon the proper curve required in the sound and the extent of surface to be left uncovered at its end.* Then heat the end of the sound in the flame of an alcohol-lamp and gently fuse the shellac over the distal third of the insulated part, noting that there is a sufficiency of the material to repair all breaks and weak spots. After it has cooled, examine it critically in a good light to see if the covering is perfect. If no change in the shape or covering of the sound is required, an immersion for a few moments in boiling water will cleanse the shellac somewhat quicker than the flame.

6. Arrange the gynecological table or couch so that it will be convenient to hold the sound in place with the left hand, leaving the right hand to manage the current controller.

Preparation of Patient.—The patient should be assured that the operation will not give her excessive pain, and may even give her no sensation beyond a slight burning. She should be warned of the necessity of keeping absolutely still to avoid shock by disarranging the electrodes or wires. Enjoin her to notify you if she feels pain, and assure her that you will instantly

* The cases of atresia reported by Apostoli as occasionally consequent upon the operation were probably due to leaving too much of the sound uncovered, as it appears from his published directions that he never insulates beyond the os. The cervical canal should always be protected unless the operation is for endocervicitis, leaving the cavity of the body only exposed to the cauterization.

lessen the current if the pain causes suffering. A free evacuation of the bowels previously assists the introduction of the sound. As a rule, the flushing of the vagina with a boracic acid solution, on arising in the morning, will be a sufficient antiseptic precaution.

She should remove the corsets and loosen all bands about the waist.

If there are any pimples or abrasions on the abdominal surface they should be covered with pieces of paper, smeared with vaseline or lard on the side in contact with the skin.

The Operation.—Besides the operative preparations just detailed, on the exact disposition of which successful results largely depend, Apostoli has divided the operation itself into three stages,—the initial stage, the middle stage, and the end. As it is an excessively technical procedure, and abounds in positions that demand an exact adherence to rule as the price of immunity from accidents, the distinct separation of these stages should be freely conceded, and an additional stage also recognized as part of the operation,—that of placing the electrodes. The following description of these several stages is intended to apply to the apparatus and instruments recommended in this work:—

Placing the Electrodes.—1. Apply the clay as already described, being sure that it is soft enough to exude beyond the meshes of the tarlatan, and lay the lead plate upon it. Attach the cord or wire of the plate to the binding post of the pole that is desired to be indifferent. If an absorbent-cotton pad is to be used in place of the clay, it is applied in a similar manner, an abundance of soapy moisture being used.

2. Attach a disconnected conducting cord firmly to the intra-uterine electrode and insert it as any other sound is inserted, using all the precautions recommended in the passage of this instrument. *Forcing of any kind is to be absolutely avoided.* If the calibre is too small for an electrode of the ordinary size, a smaller one is to be used. In some cases of intra-mural fibroids it is extremely difficult to find the os, owing to the extensive alterations of the uterus; in others, the sharp flexures produced in the canal by the presence of the growth render repeated attempts necessary before gaining entrance. Gentleness and patience are essential, and if entrance has once been gained by the most filiform instrument a positive cauterization will make subsequent introductions easy.

As a rule, the sound is to be passed by touch, and without the aid of a speculum. No one who has become expert at this method will readily return to the use of the speculum, as the sound guided by the finger becomes to a certain extent an elongation of that member, conveying intelligence with great readiness and certainty. In cases of difficult introduction it may be necessary to use a speculum and tenaculum, but both should be removed after placement has been secured, leaving the electrode to be grasped firmly by the hand during the passage of the current.

3. Glance at all the switches and connections, noting that they are tight and in order, and noting particularly that the controller contact is on the bare side of the bridge and does not touch the graphite mark.

4. Attach the cord of the intra-uterine electrode to the binding post of the pole that is to be active, and

grasp the electrode with the left hand, the index finger being within the vagina.

Initial Stage.—Turn the current on slowly at the controller, with the right hand, until a slight sensation has been felt by the patient or until thirty or forty milliampères are shown by the meter. A pause may now be made for a moment, followed by another gradual increase of ten or twenty units. As a rule, forty or fifty milliampères will suffice for the first treatment, or even less if the patient is nervous. The increase is always productive of more sensation than the steady action of the current; hence it should be exceedingly gradual. The eye, meantime, as advised by Apostoli, is alternately fixed upon the meter and the patient's countenance, to detect the first sign of intolerance of the pain, as well as follow the current increase. From the moment the current has been turned on, the apparatus and patient should be kept immovable, with the exception that the active electrode may be slowly moved in such a manner that all parts of the endometrium are brought under its action. These slight movements are always productive of some pain. No pressure should be used for fear of puncturing the uterus,—an accident that the current action facilitates.

The Middle Stage.—Having reached the current strength desired in the case, or the lesser amount that seems to be the limit of easy tolerance, the controller is held at its position for a period varying from two to ten minutes. The average of five minutes, adopted by Apostoli, agrees in the main with the author's practice, although in dispensary work the average is but two or three minutes. An extension of the time to five and

ten minutes is often advisable, but when two hundred and three hundred milliampères are in use such a long duration should be confined to tumor cases on account of the considerable destruction of tissue.

The End.—The period during which it is desirable to continue the current having expired, the action of the controller is slowly reversed, bringing the needle of the meter back to zero. The decrease of current must be almost as gradual as the increase, as suddenness in either change gives rise to shock. After the needle of the meter has come to zero the circuit is broken at some point, and the sound gently removed by carrying the handle up over the pubes in the ordinary manner. The lead plate and the clay are now removed, and, after the abdomen has been cleaned, the patient is ready to re-arrange her clothing.

After the Operation.—It is usually best to have the patient rest awhile before going home, if the operation has been performed in the office and a strong current used; but if a means of conveyance home without walking is handy, this precaution is frequently unnecessary. *In every case, however, where at least a hundred milliampères have been used, she should lie down immediately on reaching home, and remain inactive during the remainder of the day.* It is well to tell her plainly that a neglect of this precaution may cause a serious inflammation, entailing much discomfort upon her. As a necessary consequence of the operation she must look for a more or less slight sanguineous discharge during the day and evening, becoming the next day in some cases sero-purulent. I have, however, frequently given as high as two hundred and fifty milliampères without

causing a discharge to persist longer than the first day, and the method detailed in these pages for the protection of the cervix renders the discharge less likely to become purulent. The patient should be warned also that colicky pains may be felt during the day or evening, as otherwise their advent might cause uneasiness. Rest will prevent or diminish these, as a rule; but if persistent, the application of dry or wet heat to the abdomen should be advised.

In all cases an antiseptic vaginal injection should be directed once or twice a day, and if the patient is married the cessation of marital intercourse should be especially enjoined. Apostoli inserts an antiseptic vaginal tampon after the operation, but I have found this precaution unnecessary.

The Current Strength and Duration.—As the conditions in which intra-uterine galvano-chemical cauterizations are advisable vary from a slight but persistent endometritis of an otherwise normal uterus to the most extreme case of uterine hypertrophy, hemorrhage, or abnormal growths, so the efficient dosage varies through an even greater gamut of change, additionally influenced as it is by the individual idiosyncrasy as to pain. Where the hypertrophy is great, and especially where the uterus participates in the growth and abnormities of an intramural tumor, the strength is to be limited only by the easy endurance of the woman, as it is pretty clearly established that the total effect depends more on the number of milliampères in circuit than upon the duration of the application. It is true, of course, that the actual amount of electrolysis produced by, say, two hundred milliampères in five minutes can be secured by

fifty milliampères in twenty minutes; but the effect in the latter case would differ nevertheless, for it would be entirely lacking in a powerful action within the interpolar region, which is depended on to influence the contractile tissue not directly affected by the cauterization. It should be remembered also that mere electrolysis does not describe the action obtained, and that the *caustic* effect of slowly-liberated chemicals does not compare with that of a liberation *en masse*. Two hundred, two hundred and fifty, and three hundred milliampères are, however, to be reached only after the tentative use of weaker currents.

On the other hand, slight cases of subacute or chronic endometritis, unaccompanied by hyperplasia, may be effectively treated and quickly cured by applications of twenty or thirty milliampères for five minutes, and, such being the case, it is manifestly improper to subject the patient to a more heroic treatment. In cases of hysterical or neuralgic pain, in which it is thought wise to use intra-uterine galvanic applications, an even greater circumspection should be used, for cauterizations should be gauged primarily to the amount of organic disease present. I have already shown in a previous chapter that there is no way in which currents of more than twenty to thirty milliampères can be applied to the inner surface of the uterus without local action, the fancied protective virtues of a cotton-covered intra-uterine electrode being delusive.

It is a safe rule, therefore, to gauge the dose to the amount of organic change within the uterus or in tumors closely attached to it, subject to modification at any moment on the appearance of pain.

As to the duration of an application not interrupted by the appearance of pain, I have every reason to commend Apostoli's rule of five to ten minutes as an average for the whole operation, rarely prolonging the middle stage beyond three minutes. Given a large hypertrophy or tumor and easy tolerance of the current, it is better to extend the current increase rather than its duration, as there is less risk of producing breaks in the cuticle of the abdomen and the resultant burns.

The Question of Pain.—With an even, unbroken current, flowing from a good battery through a controller and through tightly-screwed cords and binding posts, as much as three hundred milliampères may be given without actual pain of any kind. The broad abdominal electrode rendering that pole non-painful, the only seat of painful concentration is at the active pole, and the uterus is fortunately analgesic as a natural trait. The patient should, nevertheless, be told to expect some pain, for there is likely to be an unpleasant excitation of the sacral plexus by the current-spread, besides the sensation of warmth on the abdominal surface. Some women complain of the sacral excitation very decidedly, especially if the uterus is situated at one side of a morbid growth.

The appearance of real pain should always be accepted as a sign for current reduction, and should lead to an immediate cessation of the treatment by a gradual reversal of the controller, for the following reasons: (1) If the pain is distinctly uterine in seat it is indicative of the presence of a perimetritis or an acute metritis, in the presence of either of which the operation is contra-indicated. It is sometimes difficult for the

patient to distinguish this periuterine pain from the intestinal colics occasionally provoked, and its recognition must depend somewhat upon the objective evidences gained in the preliminary examinations. (2) If the pain consists of a sharp burning concentrated at some spot on the abdominal surface, it is indicative of a break in the cuticle, and a continuance of the current would only develop an ulcer that would interfere with subsequent operations. This accident is particularly liable if the cotton or clay is too thin or has been permitted to become too dry. (3) Pain at the vulva or within the vagina indicates a leakiness or insufficiency of the insulating cover,—an accident that previous inspection of the active electrode should guard against.

Frequency of Operations.—Three times a week is as often as this operation can be performed with advantage. If undertaken daily the progress is likely to be checked and unfavorable symptoms arise, such as continued tenderness and augmented discharge. In many cases the local irritation within the uterus has quite subsided by the second day. If, however, time be not an important consideration, twice or once a week gives excellent results.

Contra-indications.—These operations are contra-indicated under the following circumstances:—

1. During the menstrual flow.
2. If there is an acute metritis or perimetritis.
3. If there are undoubted evidences of an abscess anywhere in the pelvis.
4. If the woman is pregnant.

A performance of the operation during the existence of an unsuspected pregnancy would be particularly

unfortunate, as abortion would certainly result. To guard against this, careful questioning, as well as an examination to detect softening of the os, should be made.

With pus in an abscess-cavity within the pelvis any procedure short of evacuation is to be condemned.

CHAPTER VI.

OPERATIVE DETAILS OF PELVIC ELECTRO-PUNCTURE.

THE details of this operation are an exact duplicate of those of an intra-uterine galvano-chemical cauterization (see preceding chapter), with the exception of the nature of the active electrode and its method of placement. Instead of an insulated sound introduced within the uterine cavity, an insulated spear or needle is thrust through the cervix or vagina into the body of the tumor itself, confining the destruction entirely to its tissue. The best operators at present condemn any attempts at puncture through the abdominal walls.

The Fibroid Spear.—This instrument is far better described as a spear than as a needle, for stoutness is an important characteristic of it, and a cutting edge at the extremity is equally essential in enabling it to pierce the dense tissue of a fibroma. At the beginning of my work in electro-puncture I was much hampered by the impossibility of obtaining an efficient "needle" for this purpose. Those made in this country were found to be defective in one or more of the following particulars: They were either not rigid enough, too dull, lacking in a proper insulating cover that would follow the needle into the tissues, or covered with insulating material that ran the risk of chipping during the process of insertion. Some were also too short for use. Apostoli's needles, as supplied by Gaiffe, are mere trocars without covering of any kind, the portion not penetrating the uterus or vagina being covered when in use by movable

glass or celluloid covers. In use, these trocars cauterize healthy tissue through which they are plunged as well as the growth itself, doing useless damage and leaving an open track for possible suppuration (Fig. 17).

The very evident importance of confining the destructive action of a powerful current to the tumor itself, after we have taken the trouble to pierce it, impelled me to have an entirely new form of needle made for this purpose. The desiderata were: a stout, slender shank, with a cutting extremity and a bared surface extending back from the point not more than a half-inch. From the termination of the bared surface to the butt end a continuous insulating sheath is required, which, as far as the handle, should be of a total calibre less than the openings to be made by the cutting edge, permitting the whole to be readily inserted into the tissues. This sheath must, if possible, form a homogeneous whole with the needle axis, and especially be adherent to the metal at the extremity next the spear-head.

FIG. 17.—FIBROID SPEAR, WITH MOVABLE SHEATH.

The material to cover the needle in this manner was for a time a puzzle, as it was absolutely unsafe to use shellac or wax for this purpose with the risk of chips being left within the tumor. The end was finally gained by vulcanizing rubber on the spear after the manner in use by dentists (Fig. 18), a small

shoulder being made at the extremity of the bare metallic surface for the point of junction. For assistance in carrying out the design I am indebted to Howard E. Roberts, D.D.S., of this city.

FIG. 18.—THE AUTHOR'S FIBROID SPEAR.

Since the pole selected for electro-puncture is usually negative, we may avail ourselves of the ordinary advantages of steel as the metal for the spear; if so, great care is, of course, to be observed not to use it as a positive pole. The point of my own instrument, which is made of gold, is shaped like a spear-head with three cutting edges, as this shape makes a wound of but small size compared with the calibre of the instrument that it will admit.

Insertion of the Spear.—A most accurate diagnosis of the position of the tumor in relation to the important organs surrounding it is first made, the patient being always placed on a table rather than on a more yielding base. The proper spot and direction having been decided upon, the needle is carried into the vagina without a speculum, the point pressing against the pulp of the finger. The most prominent part of the tumor is selected for puncture, which is done while an assistant makes counter-pressure upon the abdomen. If possible,

the spear is always made to traverse the uterine tissue to reach the tumor, as this method gives least pain. If the tumor, however, is large, and cannot be reached in this way because of its slight connection with the uterus, no scruples should prevent a piercing of the vaginal wall and traversing of the peritoneum, if the instrument and vagina have both been sterilized as much as possible, and the important pelvic organs are avoided. I have been compelled to adopt this latter path a number of times, and have not as yet met with accident of any kind. The spear should be forced in far enough to bring the exposed end completely within the morbid tissue; it need not be inserted any deeper than this.

Apostoli's practice differs somewhat from that here delineated, and he has framed the following rules for electro-puncture:—

"1st. To observe a constant and perfect antiseptic practice.

"2d. To make the punctures only every eight or fifteen days, so as to avoid accumulations of fetid matter, with temporary suspension of the sittings as soon as there are any threatenings of fever.

"3d. To make, without exception, only superficial punctures, not more than half, or, at most, one, centimeter deep, so as not to cause any central gangrene, and to admit of an incessant antiseptic treatment.

"Perforation of the bladder or rectum, followed by fistula and the wounding of some great blood-vessel, are accidents to be apprehended. I admit that a misfortune of this nature happened in one of my early operations. I now point out the way in which it may be avoided."

"1st. Never make a puncture in the anterior *cul-de-sac*.

"2d. Confine the punctures to a lateral, or to the posterior, *cul-de-sac*.

"3d. Make use of a very fine trocar.

"4th. Never introduce a speculum through which to make a puncture; and before proceeding to puncture make a minute and scrupulous examination of the part chosen for puncture.

"5th. Puncture as near as possible to the body of the uterus, from without inward, making the axis of the instrument correspond with the axis of the organ.

"6th. Choose for the seat of puncture the most prominent point of the tumor found in the vagina, making it project more, if necessary, by directing an assistant to press it downward with his hands upon the body above the pubes.

"7th. First pass the insulating celluloid sheath through the vagina, and fix it at the spot to be punctured, on the point of the index finger. Then slide the trocar up the sheath and make the puncture."

Precautions Necessary After Puncture.—Pelvic electro-puncture should be only performed under surroundings that permit the patient to be immediately put to bed, where she must remain at least twenty-four hours, a longer period being advisable if a heavy current has been used. All of my own operations have been performed in my private hospital, and, although slight febrile reaction supervened more than once, no serious inflammatory symptoms ever arose. It is generally advisable to pack the vagina over the seat of puncture with bichloride gauze, which is removed the next day and followed by antiseptic douches.

Frequency of the Operation.—Two punctures during one intermenstrual period are advisable in large tumors, the punctures being made in different spots, but in smaller growths once a month gives excellent results.

CHAPTER VII.

THE FARADIC CURRENT IN GYNECOLOGY.

THIS easily-produced current has been quite extensively used in direct pelvic applications, especially during the embryonic period of electro-therapeutic work, when the average operator considered one form of electricity about as good as another. Of late its employment has been much circumscribed as compared with the galvanic current, based on a more general recognition of its limited physical capabilities; but the same scientific considerations have also indicated certain conditions in which it is pre-eminently useful. These physical qualities and peculiarities are best studied in much the same way as advised for galvanic currents, occasion being taken for a comparison of the two at the same time.

Faradic Apparatus.—The choice of a faradic apparatus for gynecological use is by no means so important as that of a galvanic apparatus, and it is somewhat unfortunate that a number of writers and manufacturers have been led to perplex the minds of average readers with speculative differences in the currents produced by different coils. In view of the vast divergence between galvanic and faradic currents, these mystical peculiarities sink into utter insignificance, and their recognition only serves to obscure facts of real importance. As the result of a long personal study of the subject, it is my deliberate conviction that all usable strengths and qualities of a faradic current are obtainable from a

single secondary coil of sufficient power by using the ordinary means of graduation forming a part of the battery. There is even, in my opinion, no therapeutic difference between the primary and secondary currents of a faradic coil beyond the fact that the latter gives a far higher range of current strengths.* In the selection of a faradic apparatus, therefore, such questions may be safely left to the judgment of the manufacturer.

Of the more mechanical parts, certain features require to be looked into, and this is especially true of the spring interrupter. A clear note from the apparatus is important in gynecological applications, as this indicates a regular succession of currents of even strengh and duration. An irregular, jarring, discordant note emitted by a spring shows an unfitness for therapeutic work, as the irregular currents produced give unnecessary pain and fail to excite the tonic muscular action aimed at. The Du Bois Reymond method of

*The reasons given by Tripier, Apostoli, and a number of recent writers in favor of using a secondary bobbin of short, thick wire for muscular stimulation, and one of long, fine wire for sensory stimulation, are based upon theoretical considerations that embrace only a part of the facts. A short, thick wire gives less internal resistance, of course, but it also gives less volt force than a long, thin wire. Whether we get more current from the one or the other is governed solely by the ratio between this volt force produced and the total resistance of the circuit; and since we always have from a hundred to several thousand ohms to overcome outside the bobbin, a few ohms more or less within it make no appreciable difference. There is no doubt that a long wire, giving many volts of pressure, will produce greatest action on the external muscles of the body, and in the absence of exact measurements of the pressure and volume of currents from these arbitrarily-constructed coils, why not accept so tangible a test as this?

graduating the strength of the current, by sliding the secondary coil over the primary, is especially well adapted to gynecological applications when Flemming's excellent cog-wheel mechanism for moving the outer coil is added. This apparatus (Fig. 19), is too bulky for portable batteries, but furnishes the most even method of gradually increasing and decreasing the current without shock,—a desideratum in pelvic applications. The "swelling" currents advised for unstriated muscular stimulation are also most easily applied by it.

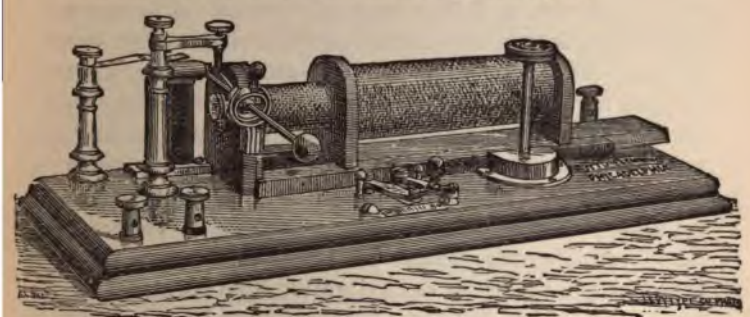

FIG. 19.—DU BOIS REYMOND COIL.

Principles Involved in the Production of Faradic Currents.—As a help to understanding the peculiarities of this current, a brief statement may be given of its mode of production.

If a faradic battery, as received from the manufacturer, be critically examined, it will be seen to consist of three parts,—a cell; an arrangement of two coils, one placed over the other, with an iron core in the centre; and one or more devices for automatic current interruption. The cell in the portable battery is usually

of the Grenét pattern, with a removable zinc and electro-poion fluid, but in stationary batteries two Law or Leclanché cells give much greater satisfaction, and save the watching and renewals demanded by the acid cell. The current from the cell does not reach the patient in any way, but is merely used to animate the coil in the following manner: From the cell it circulates through the inner coil of coarse wire, passing thence to the interrupter and back to the cell. During its passage through the coil the current makes the iron core magnetic, and thus attracts the bit of iron on the spring, drawing it toward itself and breaking the circuit. The circuit of the cell current being now broken, all magnetism in the iron core ceases, and the spring returns by its elasticity to its platinum contact, restoring the cell current and causing the same series of phenomena to be repeated. It is evident that the rapidity of this make and break of the cell current by the vibrating spring depends mainly on the distance traversed by the spring at each vibration; hence, the platinum point, which does the double duty of controlling the spring and conducting the cell current, is attached to a screw, by which this distance may be regulated with great nicety.

About the electro-magnet, formed by the iron core and the inner coil, the long, fine wire of the secondary coil is wound. It is not connected in any way with the circuit carrying the cell current, but is merely close to it. In it the currents conveyed to the patient arise by induction at the moments when the cell current is broken by the interrupter. Each current thus produced in the secondary coil is of almost infinitesimal duration (four

one-thousandths of a second, according to Blaserna). What is called the faradic current is consequently a series of remarkably short current productions, following each other rapidly or slowly as a fine spring, a coarse spring, or a pendulum is used to interrupt the cell current. The faradic current is therefore essentially a broken current, and is never continuous.*

Management of the Apparatus and Method of Controlling the Strength of Faradic Currents.—To put the battery in action, insert the zinc and make the proper connection tight if an acid cell is used; if a Law or Leclanché cell, close the cell circuit by a switch. If the interrupter does not begin action immediately, tap the screw-head over the platinum point lightly. Adjust the screw to as clear a note as possible, if it is not already adjusted. If an experiment or application be contemplated the battery should now be set for its weakest current and the secondary circuit left open somewhere, —a precaution against unwittingly shocking a patient that should be invariably followed. In gynecological applications the indifferent electrode is next adjusted in contact with the body surface, and the active electrode carried to its proper situation before the secondary circuit is closed, and the current is then gradually increased from zero to the strength desired.

Flemming's portable faradic battery is set for its weakest current when the switch rests on the button marked 1, with the tube covering the iron core *pushed in* as far as it will go. The current is increased most

* A slowly run dynamo also produces disconnected currents, but when running at full speed the inductions follow each other so rapidly as to become blended together into a truly continuous current.

gradually by *withdrawing* the tube slowly to the extent desired; the increase by moving the switch from 1 to 2, and so on, is much more abrupt, and is best done when the circuit is broken and the tube pushed in.

The Du Bois Reymond apparatus is set for its weakest secondary current when the outer coil is slid *as far away from the inner coil* as the space admits. A reverse action, *i.e.*, the sliding of the outer coil back over the inner, increases the current in the secondary coil in a very gradual manner. As the position for weakest secondary current corresponds to that for strongest primary inductions (a current, by the way, that I never use), a preliminary glance to see that the switches are right may save the patient an unpleasant surprise.

Indications for the Use of Covered and Bare Electrodes with Faradic Currents.—The use of a moist conductor to convey the faradic current through the skin to nerves and muscles beneath it is fully as important as in the case of the galvanic current; for, although the former current leaps from a dry metallic disk to the skin with great facility, and is therefore best adapted to the dry-brush method of stimulation, it expends its action at such times almost entirely on the dermic surface and nerve-ends, the polar region being extremly superficial. The moist covering permits a greater penetration and extension of this region; hence, a deeper action with less surface pain. Within moist cavities, however, the use of a moistened covering on the exposed conducting surface of the electrode is totally unnecessary, as the moisture of the cavity itself readily favors this distribution of the current. The bare electrode is,

moreover, introduced into such cavities with greater ease. The handles of such electrodes should, of course, be properly insulated, to protect the vulva and other parts not designed to be affected.

Experimental Comparison of the Electro-Motive Force or "Pressure" of the Faradic Current with that of the Galvanic Current.—(*Experiment 14.*) This may be roughly done by touching simultaneously, with dry fingers, the bare terminal wires of a full-strength galvanic battery. No current is felt, since the sixty to ninety volts of pressure in such a galvanic current are not sufficient to make the current jump through the minute layer of air between the finger and the wire; moist fingers permit a little to get through. If, now, the dry fingers be simultaneously brought in contact with the bare terminals of a faradic current of merely medium strength considerable tingling will result; its pressure is amply sufficient to cause it to leap through this air-space.

There are two practical applications of this fact besides its demonstration of the main quality of electromotive pressure: one indicates the need of a more careful insulation of the faradic current to prevent accidental shocks; and the other, the greater adaptability of this current for the electric-brush application to the body surface. It should not be understood that the greater penetrating power of the faradic current applies to good conductors, such as the moist tissues of the body, for here the galvanic current is most efficient, as the penetration is by conduction, not disruption. It is only in the disruptive penetration of poor conductors, such as dry cuticle and air, that the

faradic current shows greater power. Exact measurement of this volt force of faradic currents is, unfortunately wanting, but they probably vary from several hundred to several thousand volts.

Experimental Proof of the Inappreciable Volume of Faradic Currents. — (*Experiment 15.*) Place a milliampère meter in circuit with the secondary coil by including it directly between the poles of the battery, and turn on the full strength of the current: the meter will not show even the fraction of a milliampère. The minuteness of its volume is also shown in its failure to decompose water, salts, or organic compounds, and in the practical absence of all tissue irritation, congestion, or cauterization when it is passed through the body.

Action of the Faradic Current on Sensory Nerves and Muscles.—Notwithstanding the exceeding weakness of this current in "bulk" or "volume," the great requisite for usefulness in the mechanic arts and in the chemical destruction and metamorphosis of tissue, a slight acquaintance with its action on any part of the body is apt to impart an exaggerated idea of its physiological powers. Being essentially a series of exceedingly abrupt current creations, its power to excite the functions of nerves and muscles is unique, and the manifest phenomena of pain and muscular contraction conceal its total inability to produce profounder impressions on the body. A nerve or muscle, brought within either polar region, is thrown into action as each induction arises, just as an abrupt variation of the galvanic current, whether a rise or fall, produces a similar phenomenon. Each induction produces a separate stimulus, therefore, and it is only when they

follow each other very rapidly, as when a rapid interrupter is used, that the separate stimulations seem to blend together, producing a continuous contraction or sensation. Even then the impressions on the nerve are those of distinctly-separated though rapidly-successive currents.

The faradic susceptibility of the sensory nerves of the limbs and trunk is fully shared by those of the pelvis, although the lessened sensibility of the normal uterine and ovarian nerves permits the employment of current strengths not bearable on the skin surface. The vulva, on the contrary, like other muco-epidermic junctions, is exquisitely sensitive to this stimulus, and should be protected from it in all ordinary applications by well-insulated electrode stems. The sensibility of the vagina is about midway between the two.

Therapeutic Uses.—This current acts only on nerves and muscles, stimulating each into action, and its use is therefore limited strictly to such conditions as exhibit nervous or muscular laxity. But is this limitation a very narrow one? How many of the commoner cases met in daily practice present just these shortcomings, especially those encountered in a public clinic? The case after case of displaced and prolapsed uteri that present themselves, with or without rectocele or vesicocele, and with intact perinei, teach the paramount importance of muscular tone of the vaginal walls and uterine ligaments in the maintenance of a normal condition. When this tone has been lost, it is evidently the part of rational medicine to endeavor to restore it, if possible,—not to prolong and intensify it by erecting a false skeleton of a pessary or tampon within the vagina. Whether

this can be done by repeated applications of the faradic current is now a living question that should reach a speedy solution. Each individual application will undoubtedly provoke temporary contractions and tonicity, and, so far as known, it is the only means we have at command that will accomplish this much. The question of the permanence of this tonicity after repeated applications will be discussed in another place. For this muscular stimulation the negative pole is most efficient.

In the relief of neuralgic conditions of the pelvis gentle faradic currents are often most effective, and for this purpose I have found the positive pole (using an electrode of any kind of metal) decidedly preferable.

Beyond this neuro-muscular stimulation, with its therapeutic possibilities of direct and reflex effects, the faradic current is powerless for either good or harm in gynecology.

Electrodes and Dosage.—As a rule, the active electrodes required for galvanic applications may be used for this current, and a similar dispersion of current at the indifferent pole is advisable when used after the monopolar method. The absorbent-cotton pad will, of course, be more convenient than the clay.

The selection of the dose is purely empirical, as we have at present no means to measure this current beyond the individual scale of each instrument. The best guide to the strength required in a given case is gained from the sensations of the patient, the current having been brought up from zero to the point of easy tolerance, after placing the electrodes in position, in the same gradual manner as advised for galvanic applications. If we do not shock by a sudden turning on or off, there is

no possible way in which the patient can be harmed; so that our main point in muscular applications is to use as much current as the patient will bear, and it is astonishing how much can be given in this way with one pole in the vagina or uterus and a large dispersion on the abdomen. Weaker currents are better for neuralgic conditions, as a rule. The milliampère meter is, of course, useless with this current.

CHAPTER VIII.

THE FRANKLINIC CURRENT IN GYNECOLOGY.

THE possibilities of electrical treatment in gynecology, in the broadest sense of the latter term, are not exhausted with the use of galvanic and faradic currents. Although totally unadapted to local use, the so-called static electricity* is an agent of unique value in at least three of the conditions that are liable to present themselves to the specialist in the diseases of women, besides being useful in some other, more strictly neurological affections. These three conditions are: the *backache of nervous women*, unassociated with definite pelvic disease; *hysterical pains;* and *amenorrhœa.* In my experience, its relative value in these conditions is in the order of their mention here. In amenorrhœa I rarely use it, finding galvanic applications to the back more generally useful. In the dissipation of obscure aches and weaknesses of the back its use is sometimes truly magical, and it has the advantage of not requiring any disturbance of the clothing whatever, as in the most active mode of using it thick clothing is rather a help than a hindrance.

* The currents produced by static machines are generally, but improperly, called by the same name in this country. Such a designation involves a contradiction in terms, as the product of the battery, being a current, can no longer be *static*, or in a state of rest, although produced by static induction. Franklinic, a term honored more abroad than in Franklin's own country, offers no such objection, and is in keeping with the names of the other two currents.

The Tœpler-Holtz Machine. — The Tœpler-Holtz machine (Fig. 20) is a self-charging plate rotation multi-

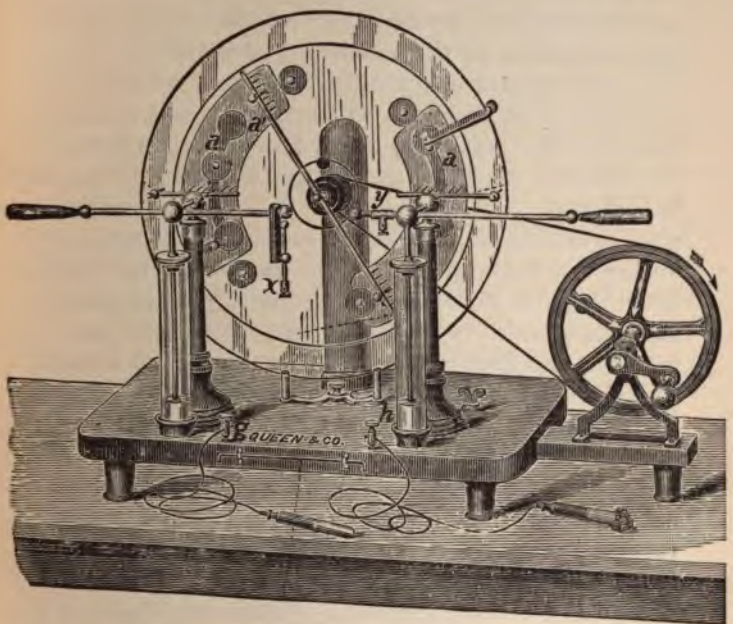

FIG. 20.—TŒPLER-HOLTZ MACHINE.—For the application of franklinic sparks and the electric spray the electrode chains are attached directly to the discharging rods, which are then to be separated. The sparks may be passed through moist electrodes placed on the body by connecting the wires attached to the binding posts, x and y, separating the rods, and gauging the sparks by the small sliding rod at x. The alternating current from the exterior coatings of the condensers may be similarly applied from the binding posts g and h. To connect these binding posts directly by means of the rod brings the condensers into action.

plier that in principle of construction and action bears a striking resemblance to the essential features of that

These are administered as follows: The patient stands upon an insulated platform (for lighter stimulation the floor will do) connected with one pole of the machine by means of a chain held in the bare hand, and with the back to the operator. The other pole is connected to a chain attached to a ball-electrode (Fig. 21) held in the operator's left hand. The poles to be selected for the attachment of the chains are the discharging rods themselves, and not the attachments below for connecting the outer surfaces of the condensers. These latter should always be disconnected unless we wish to administer a heavy charge. The attachments x and y (Fig. 20) may be removed by unscrewing the balls from the rods. The rods being in contact, the crank of the machine is turned in the direction of the arrow with the right hand, and when the current is well going the rods are separated and the ball-electrode passed up and down the back and over painful parts.

FIG. 21.—BALL-ELECTRODE FOR ADMINISTERING FRANKLINIC SPARKS.

The sparks will penetrate all clothing when dry, but the best material is loosely-woven woolen cloth. Linen as an outer covering is difficult to penetrate, the current going to the material itself, as it is a reasonably good conductor. Cotton mixed with wool makes a particularly bad insulator, as

[illegible] discharge. [illegible] browning [illegible] [illegible] by the sparks.

When the [illegible] are connected [illegible] the body surface is [illegible]

CHAPTER IX.

NON-CAUSTIC VAGINAL, URETHRAL, AND RECTAL APPLICATIONS.

THE general plan of what might be called therapeutic applications of faradic and weak galvanic currents to the female genitalia do not differ greatly from those of the more powerful surgical cauterizations described in preceding chapters. The best results are generally obtained by an adherence to the same monopolar rule, carrying the active pole as near as possible to the seat of disease, and relegating the large dispersing pole to a contiguous dermic surface. As a rule, the same kind of active and indifferent electrodes may be used with both currents, being merely careful not to use a corrodible galvano-positive pole.

In applying a galvanic current to the vagina, either for its local stimulating action on the mucous membrane, or for the purpose of bringing various portions of the pelvic contents within the interpolar region, we must be careful to avoid the caustic action aimed at in the surgical operations, which is, to say the least, undesirable when not needed. There is but one way to do this with currents over fifteen to twenty milliampères, and that is to have as large a conducting surface as practicable on the active intra-vaginal electrode. The shape shown in Fig. 22 is by far the most desirable for all vaginal applications, giving as large a conducting surface as is compatible with an easy insertion within

the average vulva. The stem is covered with hard rubber, insuring a complete insulation of the sensitive parts of the vulva during the flow of the current,—a precaution to be observed alike with both galvanic and faradic currents. Caruncles or pruritus may necessitate a direct vulvar application of the bared extremity of the electrode with either strong or weak currents, but such applications are liable to be painful with far weaker currents than are well borne within the cavities of any of the mucous tracts. To lessen the risk of cauterization, already reduced by the considerable conducting surface of this electrode, we should keep the active pole in motion when using strong currents, applying it alternately

FIG. 22.—THE AUTHOR'S MONOPOLAR-VAGINAL ELECTRODE.

to different aspects of the vaginal walls. No cotton or other moist covering is required on its surface, as the moisture of the cavity is sufficient for the intermediate conduction between electrode and vaginal wall, and its use is only troublesome. When we desire to use a really strong current (thirty to fifty milliampères), we may increase the conducting surface by enveloping it in evenly-wrapped absorbent cotton, wetting it and inserting the whole into the vagina through a speculum. The speculum should, of course, be withdrawn before the current is turned on. The large conducting surface of this electrode is of service also in faradic applications, as it enables us to give stronger currents with less local pain.

For either pole of a faradic current, and as the negative pole of the galvanic, a nickel-plated vaginal electrode surface is quite sufficient, but when the positive pole of a galvanic current is used on a mucous membrane it should be heavily gold-plated at least. The erosion of nickel or copper when used as the positive pole of even a weak current is quite remarkable, and I am not aware of any justification for such an unwarrantable staining of the tissues.

The material best adapted for a vaginal electrode to be used as a galvano-positive pole is yet somewhat uncertain, gold plate being acted upon somewhat, and platinum too expensive. Dr. A. H. Goelet has recently (*New York Med. Journ.*, June 8, 1889) recommended steel "treated by a process which renders the metal absolutely non-corrosive and non-attackable by acids." For a vaginal pole Dr. Goelet covers the metal surface with a layer of plaster of Paris, another layer of clay, and a final layer of absorbent cotton. To the writer this somewhat troublesome make-up seems unnecessary. If it be found by experience that the prepared steel has the qualities claimed for it, and I have been recently assured by Dr. Goelet that it stands the test of further experience, a bare electrode of this metal ought to be both cheap and useful. A simple wrapping with absorbent cotton, which is soaked in water before inserting, would give the additional size to avoid cauterization when currents over fifty milliampères are used. In the same paper Dr. Goelet gives an illustration of a carbon vaginal electrode (Fig. 23) that would fulfill all the requirements of the case, and makes the excellent suggestion that it be wrapped in cotton dipped in a solution

of sodium bicarbonate to intercept the acids formed at the positive pole.

An excellent carbon electrode for vaginal use may be extemporized from an arc-light carbon stick if the active end be increased to the proper size by wrapping with cotton for each application. A means of attaching the cord can be easily contrived by any ingenious person, and the intervening part insulated with a thick coat of shellac.

The middle-sized dispersing electrode (five by six inches) described at page 25 is the most convenient for use with these currents. It is thoroughly wetted and placed in position, either on the abdomen or at the small of the back (in the latter position being laid upon by the

FIG. 23.—CARBON-DISK ELECTRODE FOR VAGINA.

patient). After it is in place and connected with the battery the handle of the controller is set to the right of the rubber bridge, the meter and switch-board are scrutinized in the way described in the chapter on intra-uterine cauterizations, and the open condition of the circuit ascertained before inserting the active electrode. This is now introduced into the vagina, and the current, whether galvanic or faradic, is turned on gradually until the desired strength is attained, and at the end of the application the same gradual reduction and complete break are made before withdrawing the vaginal electrode.

The details of urethral and rectal applications are the same as those of the vaginal, with the substitution of active electrodes adapted to the calibre of these canals.

In my opinion, the negative pole should be the one invariably used in the urethra, as the concentration of current necessitated by the small electrode surface makes surface sloughs possible in a very inconvenient location. With an irritable or strictured urethra five to ten milliampères negative gives good results. For incontinence of urine, due to relaxed sphincters, occasionally seen in women, I have had most excellent results from the faradic current.

CHAPTER X.

GENERAL PERCUTANEOUS APPLICATIONS IN THE TREATMENT OF NERVOUS WOMEN.

In spite of the frequent causal association of organic disease of the pelvic organs with nervous symptoms in this region and in other parts of the body, cases occur in which such symptoms persist after all local corrections have been made, or even where no abnormalities can be found. The lesson taught by such occurrences has been forced upon an increasing number of gynecologists of late, emphasizing the need of looking beyond these organs at times for an explanation of their perturbed functions. This change of front is especially true of many cases of menorrhalgia, ovaralgia, and moderate conditions of anteflexion, when these are associated with evidences of neurasthenia or hysteria. The dilatation of small cervical canals, the wearing of a pessary, or the removal of the ovaries, alike fail to alleviate the distress which prompted the operative interference. Without indulging in this place in a discussion of the probable nature of these cases, whether due to local organic changes or to plexal or parenchimal neuralgias, hysteria, or neurasthenia, certain procedures may be described that are at times singularly happy in their relief or amelioration.

Simultaneous Administration of Galvanic and Faradic Currents.—In some of these procedures both currents are useful. They may be given simultaneously with a

saving of time and effort by simply including the secondary coil of the faradic battery in the galvanic circuit. The two currents should, of course, be made to circulate in the same direction, else one will more or less neu-

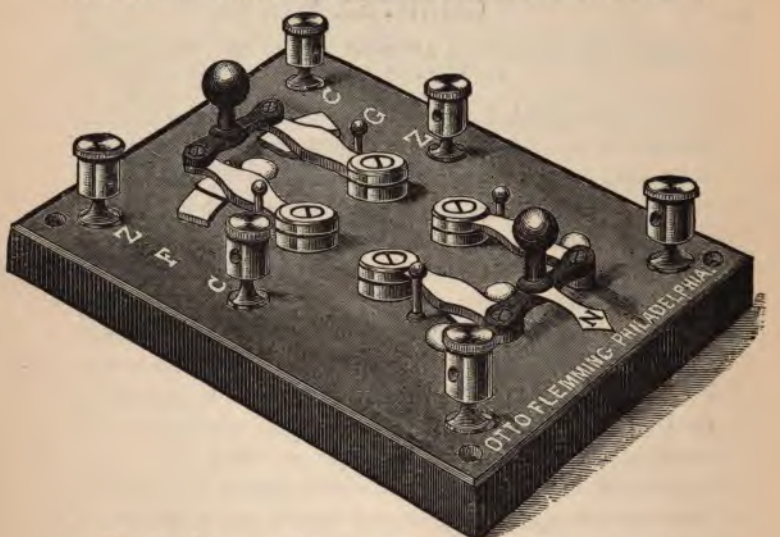

FIG. 24.—CURRENT COMBINER.—The galvanic wires are permanently attached to the upper right-hand binding posts marked with the letter G between them, that from the carbon to C, and the one from the zinc to Z. The faradic wires are also permanently attached to the binding posts designated by F, the negative to Z and the positive to C. The upper switch (to the left in the figure) is shown in the position for combining the two currents. When it is turned toward F, the current at the electrode binding posts shown at the right of the figure is faradic; when toward G it is galvanic. The lower switch is a pole changer, the index pointing to the negative, whether of the simple or combined currents.

tralize the other. A convenient arrangement of switches for combining the two currents with ease, and also for selecting either one or the other, is shown in Fig. 24.

the absence of this arrangement the two currents

may be combined by connecting the negative pole of the galvanic battery with the positive pole of the faradic battery. The positive pole of the galvanic battery will then be the combined positive pole of the two currents and the negative pole of the faradic the combined negative. The two currents are controlled by the contoller, with the assistance of the graduating apparatus of the faradic current.

De Watteville has claimed decided advantages from this double application, and my own experience has indicated its special value as a general stimulant of the abdominal functions.

Abdomino-Dorsal Applications.—The patient lies upon the back with a large (about five by six inches) dispersing electrode of wet absorbent cotton beneath the lumbar region, the clothing being protected from wetting by a folded towel or piece of mackintosh. Making sure that all current is turned off at the controller, the active electrode is next placed on the abdominal surface. This electrode should be about half the size of the dispersing pole and covered also with absorbent cotton, well wetted. The current, whether galvanic, rapidly-successive faradic, or galvano-faradic, is now turned on until the desired strength is obtained, after maintaining which for half a minute it is reduced, the active electrode changed to another spot, and the procedure repeated. To move the active electrode when the current is at its height is somewhat painful, and it is only necessary as a remedy for atonic constipation.

The large poles used in this procedure enable a considerable density of current to be carried deeply into the abdomen, and it is not only an effective way of

impressing the nerve-structures of the upper pelvis and abdomen in unmarried or modest women, but by a slight upward extension of it we are enabled to act favorably on the liver and intestines. From fifteen to sixty milliampères may be used *pro re nata.*

Spinal Applications.—The transmission of continuous currents through the spinal cord, so useful in many neuroses in which symptoms referred to the spinal region exist, is also of signal value in the amenorrhœa and dysmenorrhœa of young girls, requiring no concurrent medication if anæmia does not co-exist. The patient sits sideways in a chair with the clothing loosened at the back, and two spinal electrodes are used (about two and a half by five inches), the positive being placed immovably on the lumbar region, and the negative held in contact with the cervical and various parts of the median and dorsal regions in turn, giving a *stabile* or stationary current in each situation of a minute's duration. From ten to seventy milliampères may be used in accordance with the patient's endurance. The faradic current is not used in this manner, as it would doubtless fail to act on the cord or deep-seated nerve-roots.

General Faradic Stimulation.—This procedure, so largely used by Dr. S. Weir Mitchell as a part of his renowned "rest-cure" treatment of neurasthenia, hysteria, etc., consists in a systematic bipolar stimulation of all the accessible muscles of the body, except the face, after the manner of Duchenne; wet electrodes of medium size being used, with the current carefully graduated to produce the greatest motion with the least pain. Both rapidly successive and isolated currents are used, —the former only with the small muscles of the fore-

arm, as it is likely to give more pain. The least amount of current should be used consistent with tolerable results, especially at first. The details of the procedure, as practiced by the author, are as follow:—

If the application is made in the office, the patient removes the tighter articles of underclothing and lies on a couch; if at home or in hospital, he or she is entirely undressed and laid in a blanket, the sides of which are lapped over in front. This last method permits the freest access to all parts of the body with least chilling or exposure, as but a single part need be uncovered at a time. With the battery conveniently at hand, the first applications are made to the nearest forearm, beginning with the extensors, which are caused to contract by applying both poles to their surface, taking care to include the motor points as shown in the cut (Fig. 25). A gentle current must always be used at first in a new case, especially in nervous or apprehensive individuals, its strength being gradually increased until satisfactory contractions are produced with a minimum of pain. The electrodes are best held in one hand when treating the smaller muscles, the handle of one protruding between the index and middle fingers and pressing against the thumb, and that of the other between the ring and little fingers and grasped in the palm; with a little practice this gives easy control of both electrodes, leaving one hand free to regulate the battery or support the limb. Slowly isolated currents are preferable with delicate, non-muscular persons, the pendulum being set to vibrate at a rate that will permit relaxation of the muscles between each contraction. By the use of electrodes at least one and a half inches in diameter, each

group of muscles, *with physiologically associated action*, may be stimulated simultaneously with but slight pain, the considerable size of the electrodes permitting several

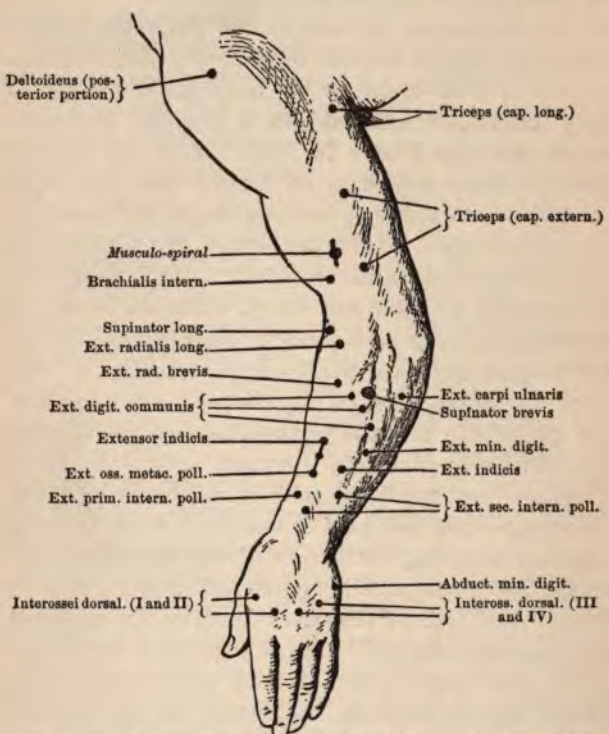

FIG. 25.—MOTOR POINTS OF DORSAL ASPECT OF LEFT ARM.

motor points to be acted on at once. After six or eight full contractions of the extensor group of the forearm, made comprehensive by slight shifting of the poles, the

anterior surface of the forearm (Fig. 26) is similarly stim-

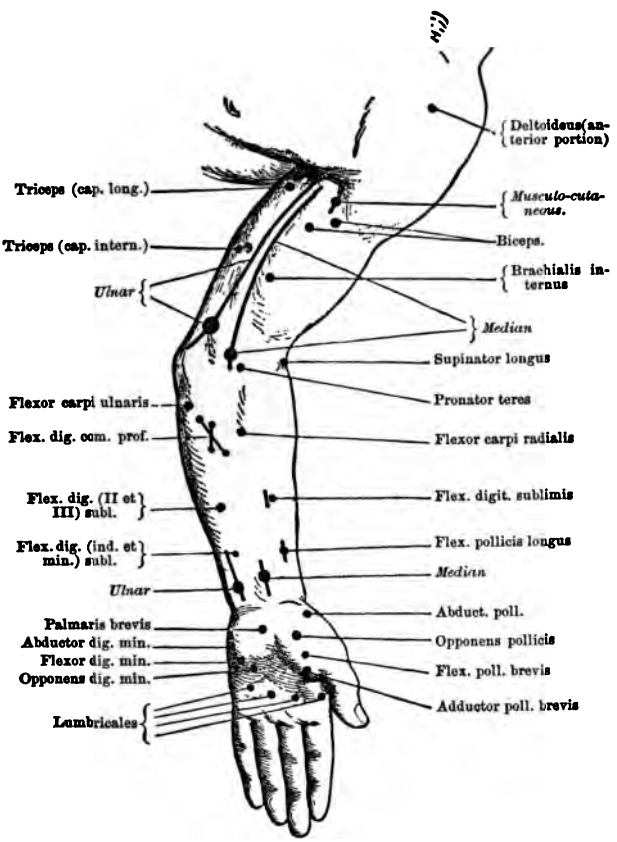

FIG. 26.—MOTOR POINTS OF INNER ASPECT OF LEFT ARM.

ulated with a weakened current, the skin here being thinner and the nerves more superficial. The next muscle

is the biceps, both motor points being covered, and care observed to avoid the median and ulnar nerves, in close proximity, stimulation of which would only confuse the work. From this group we pass to the triceps, thence to the deltoid, the pectoral muscles, the scapular muscles (taking care here to avoid direct inclusion of bony sur-

FIG. 27.—OUTER ASPECT OF LEFT LEG.

faces in the excited regions), and thence to the opposite arm. The legs next claim attention; when slightly rotated inward two positions serve to contract all the muscles below the knee,—in one the negative pole is placed on the peroneal nerve just behind the head of the fibula (Fig. 27), and the positive is moved about over

the peroneal and anterior tibial groups; in the other the negative is slid back about an inch into the popliteal space to the motor point of the posterior tibial nerve (Fig. 28), and the positive placed upon the several points below.

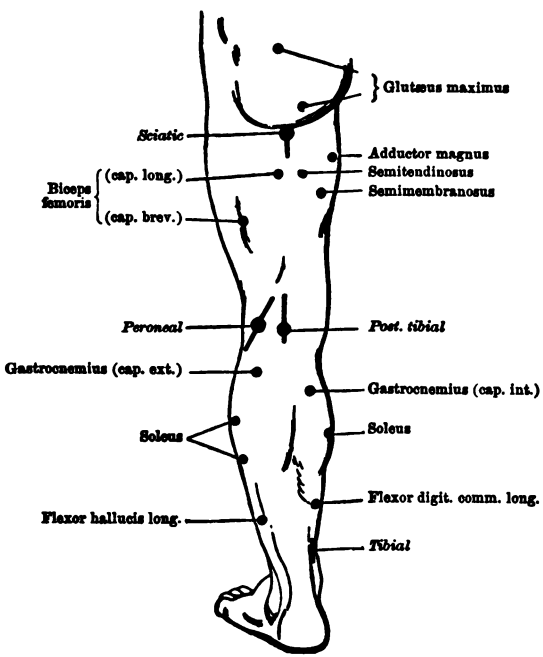

FIG. 28.—MOTOR POINTS OF POSTERIOR ASPECT OF LEFT THIGH AND LEG.

All the muscles on the anterior aspect of the thigh may be contracted by placing the negative over the external branch of the anterior crural nerve just after it emerges from beneath Poupart's ligament (Fig. 29), and the positive about the middle of thigh. The muscular planes of

the belly are now excited, and this is best done by placing the negative in different spots near and below the short ribs, with the positive swept along over the bodies of the abdominal muscles of that side. The patient now assumes the prone position, and the muscles of the back are thoroughly stimulated; the two poles (which may

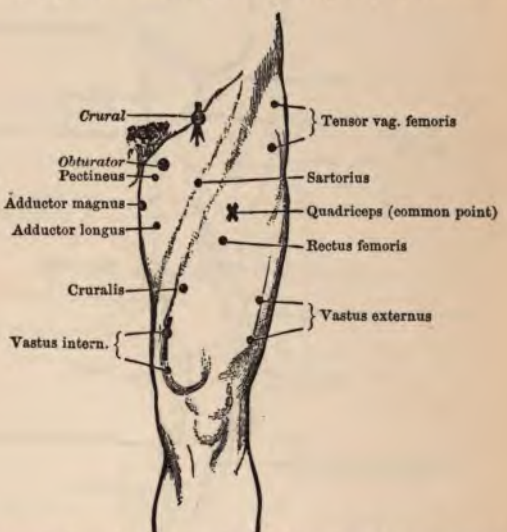

FIG. 29.—MOTOR POINTS OF ANTERIOR ASPECT OF LEFT THIGH.

here and on the abdomen be about two and a half by five inches in size with advantage) are kept on the same side of the spinous processes about five inches apart. A similar stimulation of the buttocks and backs of the thighs completes the application. Dr. Mitchell usually directs that it be followed by a sedative application of the rapidly successive current for ten minutes,

the positive pole at the nape of the neck and the negative at the heels.

Rest after treatment assists the action of the

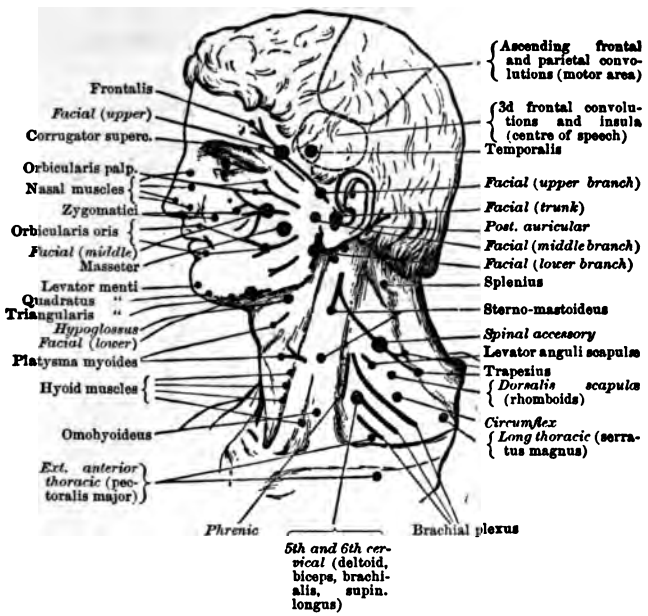

FIG. 30.—MOTOR POINTS OF FACE AND NECK.

remedy, and the patient should, if treated in bed, remain there for an hour after the termination of the application.

CHAPTER XI.

THE ELECTRICAL TREATMENT OF FIBROID TUMORS OF THE UTERUS.

THIS not infrequent affection, the treatment of which by strong galvanic currents has recently aroused such universal attention, is essentially an abnormal outgrowth

FIG. 31.—INTRA-MURAL AND SUBPERITONEAL FIBROIDS CO-EXISTING. (*Emmett.*)

from the parenchyma of the uterus, varying in size from a small nodule to a mass nearly filling both pelvic and abdominal cavities. The tumors thus formed may be firm and tough when the true fibrous or connective tissue predominates, or soft and yielding when the muscular

fibres are most numerous. The firm, fibrous variety are properly called fibromas and the muscular growths myomas, the designation *fibroid* being a general one.

Varieties Due to Situation.—According to their situation with reference to the uterus, fibroid tumors are known as submucous, intra-mural, or subperitoneal (Fig. 31). According to Winckel, 10 per cent. of living

FIG. 32.—FIBROID POLYPUS. (*Byford.*)

cases are submucous, 65 per cent. intra-mural, and 25 per cent. subperitoneal.

All fibroid tumors have their origin in the uterine wall, and fall into either of these divisions according to whether the point of development is near the mucous membrane, in the centre of the uterine wall, or near the peritoneal covering. Those that arise immediately beneath the mucous membrane, pressing toward the point

of least resistance, soon become pediculated and polypoid in shape. In this form the uterine enlargement is most equal, taking on the form and shape of pregnancy, especially when the tumor is soft or filled with trabecular cavities containing liquid (fibro-cystic). The structure of such an enlarged uterus is, however, unlikely to be so muscular and contractile as in a pregnancy, seeming rather to partake of the connective-tissue degeneration. Figs. 32 and 33 represent diagrammatically a true fibroid

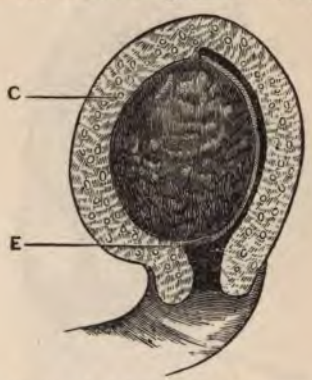

FIG. 33.—SUBMUCOUS FIBROID. (*Byford.*)
C, point of greatest resistance; E, point of least resistance.

polypus and a submucous fibroid rapidly becoming pediculated and polypoid from the influence of lines of pressure. In Fig. 34 a small intra-mural growth is shown which will continue to remain within the uterine wall and cause an exceedingly unequal hypertrophy of the organ. Subperitoneal tumors are frequently accompanied by but little change in the uterus itself, being at times merely attached by slender pedicles, but as a rule they are associated with other foci of abnormal growth in the uterine walls.

It should be remembered that in actual practice we rarely meet with a typical example of either of these varieties.

Varieties Dependent on the Consistence of the Mass.—Fibroid tumors may be still further divided into the hard and soft tumors on the one hand, and the fibro-cystic on the other, and this distinction is exceedingly important in connection with the question of the indica-

FIG. 34.—INTRA-MURAL FIBROID. (*Byford.*)

tions and contra-indications for electrical treatment. The simple fibroid appears to be prone to either of two changes when the vascular and nervous supply becomes limited by the growth of the tumor without a corresponding growth of its blood-vessels and nerves. It may become almost cartilaginous by the deposit of calcareous material (Fig. 35), or may be softened by the appearance of cysts in its substance. These cysts are usually

multiple, without any connection between their cavities, consisting of mere spaces between the fibres of the tumor filled with a watery, mucoid, or blood-stained fluid. They seem at times to be due to localized inflammatory processes, and have been reported as resulting

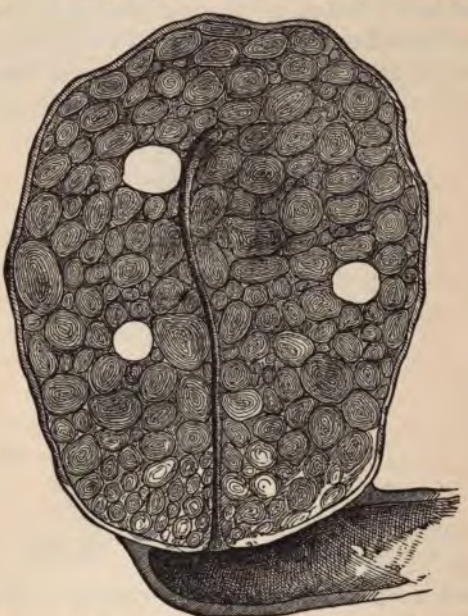

FIG. 35.—FIBROID UTERUS WITH MULTIPLE FOCI.—Several nodules have undergone calcareous degeneration. (*Emmett.*)

from electro-puncture. The red, fleshy, myomatous tumor is more likely to degenerate in this way than the dense, white fibroid.

Their Nature and Cause.—It is thought by many at the present day that fibroid tumors are in some way

related to continuous hyperæmia of the uterus, whether as cause or effect is not yet very clear. The early occurrence of hemorrhages in many would seem to make the former likely, especially since a small tumor frequently gives rise to greater loss of blood than those of the largest size. They are inclosed within a layer of compressed tissue, often resembling a capsule, but not really possessed of the reproducing power of such a covering. When once destroyed, therefore, the chance of a reproduction is by no means so great as in ovarian tumors. The fibrous tumors are supplied with nutrient nerves and blood-vessels very sparingly, generally by small filaments and vessels only at their periphery. They are, therefore, poorly endowed with vitality, giving greater scope to the depressant action of electro-chemical cauterization. This readiness of sphacelation of the tumor as a whole or in parts is a source of danger also in connection with electro-puncture, on account of the possibility of septic infection. Spontaneous inflammation of the morbid growth, or eremacausis, is not infrequent. Martin, of Berlin, in two hundred and five specimens obtained by operation, found evidences of retrograde processes, suppuration, fatty degeneration, etc., in seventy.

GENERAL RESULTS OF AN ELECTRICAL TREATMENT.

The treatment of fibroid tumors by the galvanic current, originated in its more scientific form by Apostoli, has of late been so universally recognized by the profession that a controversial presentation of the subject is here unnecessary. The warm advocacy of the method by the Keiths, Sir Spencer Wells, and several other eminent and successful surgeons is a most happy addition to the testimony of other operators than Apos-

toli, among whom may be mentioned Carlet, Delètang, and others, of France; Aveling, Holland, Stevenson, Parsons, and others, of England; Laphthorn Smith, of Canada, and Engelman, Martin, Werner, Buckmaster, Goelet, Wilson, Bigelow, and many others, of America. But, time-honored reference to authorities aside, a sober review of the author's personal experience leads to the following definite conclusions:—

1. A properly-conducted electrical treatment of solid fibroids is harmless, will remove the irritation and pain due to their presence, arrest further growth, and almost invariably cause a gradual diminution in their size.

2. Bleeding fibroids may be entirely cured of the hemorrhagic tendency and pain, arrested in growth, and gradually lessened in size.

3. It is possible for the diminution in the size of the tumor to end only in its complete disappearance.

4. In small intra-mural fibroids surrounded by unimpaired uterine tissue the current applications tend to promote their disengagement from the uterine stroma and extrusion either into the uterine or peritoneal cavities. In the former case a complete cure may result by a delivery of the tumor, and in the latter case a lessening of its symptomatic importance.

5. The time necessary for a satisfactory shrinkage should not be too sparingly measured with the slow cases. Quick symptomatic cure and slow shrinkage are often associated in the same case.

6. In fibroid tumors that have undergone cystic degeneration a treatment by strong currents may do harm, being apt to set up changes in the liquid contents of the cavities that may result in septicæmia.

The first two or three applications, even if strong ones, do not usually cause an appreciable diminution in the size of the tumor, but a striking and almost invariable result is a prompt disappearance of any tenderness about the mass. A number of cases in my experience have been relieved of this annoyance in great part after but one treatment. At times this result will be attained but slowly, and in these cases, as pointed out by Apostoli, some pronounced disease of the appendages co-exists. If there be a fetid or too abundant leucorrhœa, its early correction may be looked for with confidence.

My experience also fully confirms Apostoli's claims as to an improvement in the general health of these cases. So much is Apostoli impressed with this fact that he recommends that a measurement of the adipose tissue of the abdominal walls be made by means of calipers before and during the course of treatment, lest their increased thickness be allowed to conceal the reduction in the size of the tumor. This increase in the abdominal fat I have noticed in a number of cases; in a recent instance it was so marked as to lead the patient to erroneously think herself pregnant. Stimulation and regulation of the appetite and bowels are particularly noticeable, and women who have been chronic invalids for years soon present evidences of blooming health and unimpeded activity.

Mode of Action.—Much misconception has existed as to the probable *modus operandi* of electricity in thus affecting fibromas. The idea that it is due and proportional only to the actual destruction of tissue at the active pole is clearly wrong. If such were the case there would be no explanation of the shrinkage of a

subperitoneal growth after intra-uterine applications, particularly where the growth is only attached by a pedicle. A typical result frequently seen—the re-appearance of a lobulated condition during shrinkage—is equally difficult to account for under such a theory. A view more generally accepted is that a retrograde metamorphosis of the morbid tissue is favored by the current, acting on the lines of denser current-flow in the interpolar region as well as in the polar region. That the interpolar transfer of particles incidental to electrolysis might have such an effect is certainly conceivable, even in the face of the well-known fact that the same current action promotes nutrition in muscles, for an analogous stimulation of normal and depression of abnormal processes is the province of most therapeutic agents. The low vital resistance of morbid tissue is well known, yet exactly why a current of great milliampère power should lower the trophic activity of this variety must remain somewhat uncertain, and we are not likely to know more of it until the etiology of these morbid growths is more clearly understood. To my mind the electric applications are like blows upon a nerve containing trophic filaments, which are followed by degeneration and absorption of the supplied area in proportion to the injury. The results in both instances are practically a vital reaction from the injury, and they necessitate the cooperation of active absorbents. From this point of view the challenge of Bantock concerning the reduction in the size of a tumor held in his hands is utterly misplaced; as well might he cut some muscles from a cadaver, and challenge Erb to produce the muscular changes indicated by the now classical reaction of degeneration.

In certain cases an additional mode of action is probably added to this. The concentration and power of these currents produce a contraction of the muscular tissue of the uterus surrounding intra-mural growths, even when turned on in a gradual and uninterrupted manner—a contraction of the tetanic character that is well known to appear in all muscular tissue during current duration when the strength is overwhelming. In myomatous cases this causes an immediate hardening and decongestion, and is doubtless the explanation of some remarkably quick results occasionally observed.

The enucleation and delivery of a fibroid tumor by electrical treatment should be looked upon as only possible in the most favorable cases. Apostoli, it is true, disclaims the possibility of such a speedy and complete cure, but there can be no doubt of this result under exceptional circumstances.

An instance of complete extrusion of an intra-mural fibroid, the dimensions of which are not given, but which was probably quite large, is reported by Dr. Mary Putnam Jacobi in the *American Journal of Obstetrics* for August, 1888. The patient, æt. 36, had suffered from a uterine fibroid for at least six years, which, at the beginning of the electrical treatment, was situated in the uterine wall posteriorly and to the left. Thirty-eight galvano-chemical cauterizations were administered during the space of six months, followed by a presentation of the tumor at the dilated os and delivery through the vulva by the operator. A menorrhagic tendency was corrected early by the applications, some of which were positive and some negative, with a

usual strength of two hundred milliampères and ten minutes' duration.

Another case reported by Dr. E. Holland (*Brit. Med. Jour.*, January 7, 1888, page 20) adds confirmatory evidence of the same nature. Dr. Holland's report of this case is as follows :—

Mrs. C., aged 38, having seven children, was admitted to the Woman's Hospital, Soho Square, London, July 4th, severely blanched and flooding. The uterus was involved in a hard, multiform, fibroid enlargement, whose measurements were as follow: Upper limit, level with the middle of umbilicus; right lateral limit, five inches to right of middle line; left limit, three and a half inches from middle line; transit of sound, six and a half inches to seven inches. The hemorrhage resisted all ordinary resources, and, as there was no cervix available for a stump, electrolysis was considered a legitimate procedure, and was accordingly begun on July 22d, as follows: The negative electrode, insulated to four and a half inches from its extremity, was placed in the uterine cavity, whilst the positive electrode was connected with the zinc and potters' clay distributor of Apostoli and applied externally over the tumor. A current of fifty milliampères was gradually produced and allowed to flow for ten minutes. On the 25th the application was increased to eighty milliampères, on the 29th to one hundred and fifty milliampères. After this there was pain for an hour, and the tumor was perceptibly diminished in area. On August 2d there was again free hemorrhage and clots passed for several days. On August 9th, the hemorrhage still continuing, positive cauterization to two hundred and fifty milliampères was

maintained for twelve minutes, with the result that the hemorrhage was arrested and never recurred. August 12th, negative cauterization two hundred and fifty milliampères.

On this and subsequent occasions the patient appeared less tolerant—August 15th, to two hundred and fifty; 18th, to three hundred; 22d, two hundred and thirty-five. After the application on August 22d the patient suffered chilly feelings; thought she had taken cold, and had raised temperature and vaginal discharge, which became more and more fetid. August 27th, much pelvic pain was noted. August 29th, fœtor increasing; cavity of uterus well douched, after which the temperature shot up to 103°. Between the last date and September 4th a large, sloughing mass was bloodlessly enucleated and extruded into the vagina. September 5th, mass removed by two applications of the écraseur and other small enucleations by fingers and scissors from a base which was found to be the left lateral wall of the uterus inverted. After the operation the inverted left lateral wall was manually replaced. Between the date of this operation and the 8th a second bloodless enucleation and extrusion was accomplished, and of a much larger mass, which tightly distended the vagina and was removed by three applications of the écraseur and one or two twisting processes. On the second evening after this operation the temperature rose to 104°, but this was quickly subdued by quinine. The douches were most thoroughly used every three or four hours, chlorine water being the usual one, whilst quinine was freely given at each rise of temperature.

On September 15th the patient was quite convalescent

and the discharge scanty and without fœtor, the sound passing two and three-quarter inches in and no tumor being perceptible. From the commencement of the electrical treatment to the date of convalescence was exactly fifty-five days. Dr. Holland adds: "It is also well to observe that the tetanoid condition into which the uterus was thrown by the electrical application led us to anticipate necrosis and enucleation as possible and probable contingencies, and, in doing so, to draw attention to the extreme importance of the galvanic current as a diagnostic agent in all solid uterine tumors."

The result in both cases was clearly due in great part to a stimulation of the uterine muscle, and it is reasonable to hope that the cramp-like pains usually complained of by patients undergoing an application will always tend to have this happy result in appropriate cases. That these cramps, which usually require at least one hundred milliampères for their production, are attendant upon real contractions of the muscular tissue, is proven by the appearance of identical pains during the use of much weaker currents in cases of recent subinvolution, where the muscular fibres are much better developed. In one such case a distinct grasping of the electrode was detected by the author while using eighty milliampères, the patient declaring that she felt as if she were in the throes of parturition.

The serious dangers through which Dr. Holland's case passed can hardly be attributed to the current, as it is evident a necrotic process was threatened before her admission to the hospital.

Choice of Cauterization or Puncture.—I have no hesitation in saying that in all cases of intra-mural

tumor, in which the cavity admits an electrode, and in which an electrode so placed will concentrate the current through the body of the tumor, intra-uterine cauterization is to be preferred to electro-puncture. Under such circumstances nothing whatever is to be gained by puncture, particularly when the cavity is more or less surrounded by the growth. Puncture is best reserved for two emergencies: *a.* When the cavity of the intra-mural tumor cannot be entered; *b.* When a subperitoneal tumor has its uterine attachments so stretched as to place it beyond the effect of intra-uterine applications.

As to the first indication for puncture, I rarely encounter a cavity so distorted as to be proof against patient but gentle attempts at entrance. Filiform electrodes, with a small bulb at the extremity, are at times useful for this purpose, and the elastic electrode figured at page 58 is invaluable.

Concerning the relative value of electro-punctures and intra-uterine cauterization, opinions now differ. Mundé, in a discussion of the subject before the Obstetrical Section of the New York Academy of Medicine, November 27, 1889, looked upon the intra-uterine treatment as slow compared with puncture, claiming to have caused at least four tumors to disappear entirely by the latter method. The author is inclined to attribute this difference in his results to the use of too weak a current in the applications to the cavity. Powerful currents concentrated at the end of an electrode within the cavity cannot differ greatly from puncture in intra-mural cases. If the strength be over two hundred milliampères a slight puncture is practically unavoidable, even with a

been aspirated and drained is at least open to question. Dr. Gehrung, of St. Louis, has recently suggested a method and devised an instrument, made by the Leslie Instrument Company of that city, by the use of which it seems possible that these cases may be treated by electro-puncture without danger.* He gives the following description of the instrument (Fig. 36) and directions for its use :—

FIG. 36.—GEHRUNG'S ELECTROLYTIC TROCAR AND CANULA.

The trocar, including the handle of two and three-fourths inches, measures seven and one-half inches. The steel of the trocar reaches through the handle and terminates below in an expansion or bell to receive the tip of the conducting cord. Its stem is four and three-fourths inches long, and rests, with the exception of the point, in the canula. Just behind the point the stem is thinner than elsewhere, so that the canula, by means of spring-power produced by a slit in its distal extremity, will be prevented from causing any unevenness that might impede its introduction. The canula measures four and three-fourths inches in length, and, being arranged on the principle of a double canula, it has, inserted at an acute angle, an arm or canula one and one-half inches in length, almost parallel to the straight tube, while the distal end of the tube is provided with a number of perfo-

* *American Journal of Obstetrics*, August, 1888, p. 820.

the two electrodes is too great to be materially overcome by a current with a pressure of but one and a half volts; but a small number of milliampères could therefore get through, and the actual number at each operation would depend on the nearness of the electrodes to each other. That the current actually used was trifling is evidenced by the fact that they were able to withdraw the steel needle used as a positive pole almost as easily as the negative needle. A hundred milliampères would have attached it firmly to the tissue of the fibroid.

While lacking in value as testimony to the efficiency of electricity in large doses, these cases are nevertheless exceedingly interesting, as showing the exact danger attending the thrusting of an instrument into a solid tumor through the abdominal walls and the good effects that may at times result. That the vagina should be the preferable point of departure is pretty well settled, though, and the principal reason, besides the avoidance of the peritoneal cavity and the intestines, is the ease of drainage afforded in this situation, when drainage is required.

Soft, Varying to Firm, Fibroids are the best adapted to electrical treatment. Very hard tumors respond more slowly. In one of the author's cases mentioned under the head of Subperitoneal Fibroids, there was, nevertheless, considerable shrinkage in spite of the cartilaginous condition of certain parts of the growth.

Fibro-Cystic Tumors are not regarded at present as favorable cases for electrical treatment. Cases have been reported in which the cysts degenerated into abscesses, ending at times fatally. Whether such a termination would have occurred if the cavities had

favor matting together of contiguous parts and the production of continuous walls to the opening. I have adopted the opposite course of insulating all parts of the needle not embedded in the tumor, and it would seem that this would be preferable when drainage is already secured by the use of this apparently excellent device.

The trocar and canula being plunged to the requisite depth into the tumor or cyst, the conducting cord of the *negative* pole should be attached to the handle of the trocar and the current turned on as described elsewhere.* This done, the trocar is withdrawn, and the fluid, if any be present, allowed or made to flow away through the canula, which is left in position.

The cyst being drained, the next step is to introduce the inner canula into the space previously occupied by the trocar. After attaching the rubber tubes and aspirator as described, the cyst can be washed by antiseptics and alterants, as carbolic ($\frac{2}{100}$ to $\frac{4}{100}$), mercuric bichloride solutions ($\frac{1}{1000}$ to $\frac{1}{2000}$), iodoform oil (twenty grains to one ounce), tincture of iodine even to full strength, etc. By means of this apparatus these medicaments can be applied by aspiration or irrigation, as the operator may desire.

When the cyst is cleansed and treated to satisfaction, the inner canula can be withdrawn, while the outer remains as a permanent drainage-tube; one of the two arms of the canula should now be closed by a cork of wood or metal, and the other should be closed by a per-

* The escape of hydrogen gas and the liquids produced during the operation will be assisted if the trocar is removed before turning the current on.

forated metallic tip, to which is attached a very soft rubber bag (a child's rubber balloon will do) for the purpose of collecting for inspection and examination all fluids that may pass through the canula between visits. In this way the cyst or wound is hermetically sealed, without arresting the constantly secreted fluids within.

The washing, etc., should be repeated about once a day.

After the removal of the aspirating apparatus nothing can be seen except the little rubber bag, as the whole drainage-tube is safely ensconced within the vagina, just reaching to within the labia majora, enabling the patient not only to lie down with comfort, but to sit up, walk about, and to micturate and defecate with ease.

If there is no fluid present, of course, the trocar and canula may, after the use of electrolysis, be removed simultaneously, unless it be desired to leave the canula for future applications of this agent without the necessity of a repeated puncture. For the application of the current, either the trocar may be re-introduced through the canula and the cord attached, or the latter may be attached to the canula itself. A silver canula seems to be sufficient, as only the negative pole is to be used. In Dr. Gehrung's case it came out but a little tarnished after sojourning twenty days in an abscess-cavity. Twenty-four hours after its removal no sign of the wound could be traced.

In the article alluded to, Dr. Gehrung reports a case of exudation tumor of fifteen years' standing, developed around a subserous fibroid, in which four or five electro-punctures with a solid needle had been made. Shortly

after the last puncture evidences of pus formation set in, and the tumor was found to be enlarging. At this juncture the cyst was punctured through the vagina with an aspirator needle, and a large quantity of serous fluid and about an ounce of pus drained away. This was followed by a fall of temperature. The opening was enlarged and a double uterine aspirating canula introduced. Failing to keep this in place, the instrument described (Fig. 36) was introduced into the tumor, which had meanwhile developed symptoms of a re-formation of the abscess. It was kept in place until the flow was completely arrested. During this time the cavity was washed out daily with 2-per-cent. carbolized water, followed by iodoform oil and pure tincture of iodine. Occasionally, electrolysis was repeated, in the hope of securing further modification of the cyst-walls. The patient made a good recovery.

Electro-puncture and drainage with this instrument seem to be particularly promising in simple cysts situated in close proximity to the vagina, but the author would hesitate to recommend it in those located in solid tumors. It is barely possible that it may bring ovarian cysts within the province of electro-puncture, as the results with the solid needle have not been encouraging.

Fibroid Polypus.—When in the shape of polypi, an electrical treatment should be declined, unless the polypus is small and hard; for the surgical treatment of intra-uterine polypi is clearly feasible and reasonably free from danger, under which circumstances it should always have the preference. After the heavy mortality suffered by the last generation from the practice then in vogue among surgeons of slow strangulation of these

growths (*vide* Barnes' "Diseases of Women"), we should be chary of repeating a similar invitation to septicæmia. This is especially true of all soft, fibro-cystic, or vascular polypi of large size. The disintegrating power of heavy currents is so great in these soft tumors, so largely cut off from trophic influences, that an exceedingly ready necrosis occurs, with the consequent danger of septic infection. If the polypus be of the harder variety, cauterizations, negative in non-hemorrhagic and positive in the hemorrhagic variety, are far less likely to be attended by this risk, and may speedily end in spontaneous contractions and expulsion. Under these circumstances the currents should be of short duration (one to two minutes), but carried to the full strength tolerated by the patient.

After the removal of fibroid polypi from the uterus a course of galvano-chemical cauterizations of the cavity is exceedingly useful, the author being confident that he has prevented the development of other nuclei in this way in a number of cases.

Submucous Fibroids.—Where the tumor merely projects into the uterine cavity, its treatment by properly regulated galvano-chemical cauterizations offers the best hope of either an entire disappearance by absorption or enucleation, or an atrophic dwindling into innocuousness. If there is hemorrhage, the positive pole must, of course, be used, followed by the negative, for its greater denutritive power, as soon as the hemorrhage has been sufficiently controlled. The following case may be taken as a fair illustration of the results of the electrical treatment of this variety.

CASE I. *Small, submucous fibroid associated with*

CASE VII. *Subperitoneal tumor in right cul-de-sac loosely attached to uterus. Three electro-punctures, resulting in one-third diminution of bulk and relief of symptoms.*—Miss M. W., aged 46, who had been under the author's care for the sequelæ of rheumatism, was also troubled with a tumor in the pelvic cavity, lying to the right of the median line, and extending about an inch and a half above the pubic bone. Examination showed an ovoidal, hard mass lying to the right of the uterus, which it displaced, and measuring about five by three inches. The uterus was normal, and only moderately adherent to the tumor, which had existed a number of years. There were signs of pressure upon the veins of the legs by the tumor, and the bladder was exceedingly irritable.

February 11, 1888, the patient entered the author's private hospital, and on the 12th negative electro-puncture was performed, the needle being thrust through the vaginal wall into the most prominent part of the tumor. One hundred and fifty milliampères were used for two minutes, causing great pain. It was subsequently found that the insulating cover of the imperfect needle used was chipped, and that the vagina was cauterized. Beyond this there were no bad effects.

February 16th. Second electro-puncture. The insertion of a new needle was almost painless, but it was found to be too short, the current leaking to the vulva from the handle. Sixty milliampères were employed for one minute.

February 19th. Attempt at electro-puncture. The fibroid spear shown in the cut on page 75 was devised and employed for the first time. Its insertion caused

great pain, and, as there was some doubt felt as to where the point was, no current was given. There was no reaction.

February 23d. On examination, there is a cavity where there had been a protuberance in the tumor, and the whole mass is considerably reduced in size. Further treatment postponed until next intermenstrual period.

March 14th. Third electro-puncture. Insertion of spear caused considerable pain. It was made to penetrate about a half-inch into the tumor, somewhat above former puncture, and was connected to the negative cord. Two hundred milliampères were used for two minutes. There was a sanguineous discharge for eight hours. No rise of temperature.

October 15, 1888. The patient has been out of the city. Considers herself practically well, having no trouble now with her bladder. Examination shows the tumor fully one-third less than before treatment.

December 1, 1889. Has continued to have no symptoms referable to tumor. Is unconscious of its existence. Examination shows it somewhat smaller.

CASE VIII. *Three-lobed subperitoneal tumor springing from posterior walls of uterus and filling pelvis and lower third of abdominal cavity, accompanied by an offensive discharge. Exploring needle detected calcareous degeneration of an upper lobe. After twenty-two intrauterine applications there is a distinct lessening in size and relief from the discharge and menorrhalgia.*— Sarah S., single, aged 41, was referred to the writer April 14, 1888, by Prof. Frank Woodbury, under whose care she had been for some years. A lump was first noticed in the abdomen about twelve years before, at

which time she was greatly troubled with an excessive flow at the menstrual periods, accompanied by great pain. Of late the menstruation had become more normal in amount, but remained painful. Between periods had an exceedingly offensive leucorrhœal discharge, of a greenish-yellow color.

The pelvis and lower third of the abdomen were filled with an irregular, hard mass, extending nearly to the umbilicus, and separated by deep sulci into three lobes. The os was found with difficulty, but was so stenotic as to foil all attempts at inserting a sound or electrode.

April 15th. Unsuccessful attempt to insert a small Sims' sound.

April 20th. Patient seen with Dr. Woodbury with a view to electro-puncture. The central lobe, which, owing to its thickness and irregular shape, presented a bulging protuberance in the median line, was so hard as to excite suspicions of calcareous degeneration. A steel needle was thrust into it through the abdominal walls, but could not be made to penetrate beyond a couple of lines. Electro-puncture abandoned.

April 25th. Filiform sound, insulated, passed into cavity of uterus two and a half inches with much difficulty. Negative cauterization (the sound being copper), sixty milliampères, five minutes.

April 27th. Sound made of No. 18 copper wire tipped with solder and insulated with rubber tubing was inserted more easily. Negative cauterization, eighty milliampères, five minutes.

May 4th. Os and cervix more normal. The offensive odor and character of the leucorrhœal discharge

entirely changed. Negative cauterization, one hundred milliampères, five minutes.

May 11th. Ordinary platinum electrode inserted with difficulty. The uterus was found in front of the tumor very much anteflexed. Positive cauterization, one hundred milliampères, five minutes.

May 18th. Electrode inserted two and a half inches with ease. Positive cauterization, eighty milliampères, five minutes.

May 25th. Negative cauterization, two hundred milliampères, three minutes.

At this time there was some diminution in the size of the tumor and the patient was free from any leucorrhœal discharge. As this patient was compelled to earn her living, the applications were made not oftener than once a week. Each treatment gave her some pain, owing to the superficial situation of the uterus, and on this account these and the subsequent applications varied in strength from one hundred to two hundred milliampères, generally being not more than one hundred and twenty-five. During June five applications were made; during July, three; August, five; September, two; and October, one. The second application in September was inadvertently close to a menstrual period, and was followed by the first menstrual pain experienced since beginning the treatment. There was also at this time some fever.

November 16th. The present condition of the patient is as follows: General health much improved; no leucorrhœa; no menorrhalgia; cavity of uterus presents a normal curve; considerable shrinkage of the tumor, probably one-third. Instead of being three-lobed it

now consists of three distinct tumors, movable upon one another. Patient symptomatically cured, but still under treatment to lessen size of tumor.

Bleeding Fibroids.—As the complication of persistent uterine hemorrhages with a fibroid tumor leads to certain definite peculiarities of the electrical treatment, it is of practical utility to consider bleeding fibroids as a separate class. From the pathological point of view they differ from others only in being associated with a hemorrhagic endometritis, the fungous granulations of which bleed at irregular intervals or continuously, under the stimulus of the neighboring growth. Many intra-mural fibroids that subsequently do not present this feature first announce their presence by menorrhagia or metrorrhagia, and it is commonly supposed that an intra-mural origin in close proximity to the endometrium is the determining cause of the hemorrhagic disposition.

The electrical treatment of this variety is particularly interesting as presenting opportunities for the exercise of the most delicate judgment, and giving often the most brilliant results. A symptomatic cure, combined with reasonable anatomical skrinkage, means much in these cases, for it assures the complete disappearance of the hemorrhage—a most troublesome and at times dangerous feature of the disease. The assertion that these hemorrhages are beneficial is utter folly, as they are generally attended by pain and rise of temperature; if unaccompanied by these symptoms, and followed by subsidence in size of tumor, the evidences are that the flow is menstrual and not a hemorrhage.

It is my conviction that every case presenting this condition may be symptomatically and permanently

cured by positive intra-uterine cauterization. Many of them present little difficulty in treatment, mainly those with small cavities, that can be thoroughly cauterized with ease. The positive pole is, of course, to be used invariably, and in the small cavities the author's stiff or flexible platinum electrode is sufficient. With larger cavities the difficulty increases. It is easy to understand that the morbid condition of the endometrium demands that larger areas of electrode surface be used with correspondingly increased currents, or that a definite, small electrode surface be applied successively to various sections of the surface of the cavity, but the nature of the conditions present make this easier said than done. The endowment of a considerable experience in such work cannot be communicated in writing.

Apostoli has devised a set of graduated electrodes for this purpose constructed of carbon, which is cheap and doubtless even more incorrodible than platinum. The series consists of seven sizes of carbon tips, each the same length (two and a half centimetres) but with increasing diameters. These are interchangeably attached by a screw to the metallic stem. The stem, covered with hard rubber, is graduated by means of circular grooves placed two and a half centimetres apart. In use the largest sound readily admitted is first employed, after previous careful cleansing in a strong antiseptic solution, and the others are used in succession at succeeding sittings until the entrance of the cavity is sufficiently dilated to admit the use of one that will thoroughly cauterize all irregularities of the endometrium.

Apostoli's directions for their use are as follow* :—

* Bigelow, "Gynæcological Electro-Therapeutics," p. 85.

1st. After disinfection in some strong antiseptic solution, in order to secure full cauterization, the instrument is inserted as far as it will go, if possible to the end of the uterine cavity.

2d. When the electrode is in this position the highest bearable current is turned on, and we judge of the necessity of augmenting by the effect of previous operations. The current strength must be increased when the larger electrodes, which present greater surface, are used.

3d. The first stage of cauterization being finished, the instrument is withdrawn just as much as the length of the carbon, and in that situation the second cauterization is effected the same as the first, and so on, changing the position of the carbon till all the interior of the uterus is cauterized, section by section. To do this methodically an index finger is passed into the vagina and pressed upon the first circular groove beyond the os, being retained in this position while the electrode is drawn out until the next groove appears in the same situation.

4th. It is better, if possible, to cauterize the entire cavity at one sitting, letting each sectional cauterization last from three to five minutes, as the gravity of the case and the size of the cavity may show to be proper.

5th. In continuing the treatment, the duration and force of the current must be made to depend upon the effect produced by the cauterizations at previous sittings.

The author has usually found it best to decrease the current considerably before changing the position of the electrode on account of the pain produced. One disadvantage connected with a carbon electrode mounted in this way is that the extreme heat of the alcohol flame

is inadmissible. In some carbon electrodes, constructed from solid arc-light sticks by the author, and insulated with shellac, a red heat is easily borne a number of times without deterioration, and the cheapness of the sticks renders this method of cleansing practical. Prolonged boiling would seem to be the only other method of safely cleansing such porous material.

A disadvantage of the carbon electrode in many cases is its rigidity. This has been overcome in the case of the bulbous electrode by flexible contrivances designed by both Franklin Martin and Buckmaster. In these a flexible bougie of insulating material of a size proper for the case forms the basis, the conducting surface being made by a coil of fine platinum wire near the tip. In Dr. Martin's electrodes, which are quite flexible, the exact size of the exposed surface is determined in square centimetres, in order that a minimum current strength of twenty-five milliampères per square centimetre may be used, his investigations leading him to the conclusion that nothing under this density will cauterize. These compound electrodes present many interstices for the lodgment of decomposing material, and should never be used without previous thorough boiling. They certainly respond to this method of cleansing as well as porous carbon. Their flexibility renders them preferable in a certain number of cases.

An important reason for the use of bulbous electrodes fully as large as the cavity will admit in these hemorrhagic cases is that this form prevents the wounding of the surface that attends the use of smaller sounds in large cavities.

Rest after treatment is more essential with bleeding

fibroids than with non-hemorrhagic varieties. In my private sanitarium the practice is to keep the patient in bed from sixteen to twenty-four hours after each treatment. The following cases may be cited as an average illustration :—

CASE IX. *Large hemorrhagic fibroid with small cavity. Return to normal menstruation and complete disappearance of the tumor after eight cauterizations.*— Mrs. M. D., aged 34; seven children, youngest two years; one miscarriage; was admitted July 22, 1889, flooding profusely. This was the first attack of hemorrhage recently, but she had had a bad one two years ago, and had suffered from pain and leucorrhœa since the birth of the youngest child.

Examination showed a large intra-mural fibroid filling the pelvis and extending above the level of the anterior superior spine of the ilium, firmly wedged. Sound entered but two and one-half inches. She was immediately given a positive cauterization of the cavity of one hundred and ten milliampères, which controlled the hemorrhage. After the second cauterization (one hundred and twenty-five milliampères) there was a perceptible diminution, and after the fourth (eighty milliampères) the patient was free from all symptoms. The next period was, nevertheless, free, but on its subsidence the tumor was scarcely perceptible. The treatment was now continued, eighty milliampères being given August 16th, and again September 2d and 13th, and finally sixty milliampères September 16th.

Examination December 10, 1889. No tumor can be found by either external or internal or combined palpation, the only evidence of its existence being a thick-

ening of one side of the os. Her menstrual periods are regular, lasting three days, and she has gained flesh and strength to the degree of perfect health. An accumulation of fat in the abdominal wall gave rise to a belief on her part that she was pregnant, but there is no sign of this.

CASE X. *Hemorrhagic fibroid, mainly involving cervix. Control of hemorrhage and symptomatic improvement after five cauterizations.*—Mrs. M. M., aged 33, was first seen October 25, 1889. She had been flowing every day for two years, and was blanched and nearly exsanguinated, with every evidence of profound anæmia. For the previous two weeks the flooding had been particularly profuse. A fibroid the size of an orange, involving the cervix particularly, was found. Cavity entered but a short distance. She was immediately given seventy-five milliampères, positive, to cavity, and the results awaited. The bleeding was checked promptly, and had ended on the third day. But one additional treatment could be given before the next menstrual flow, which appeared November 5th, lasting but six days, and less profuse than usual. The case is still under treatment, with the object of reducing the size of the tumor, but there has been no further hemorrhage.

CHAPTER XII.

THE ELECTRICAL TREATMENT OF UTERINE HEMORRHAGE.

Menorrhagia.—The faradic current is the proper form of electricity to use in recent hemorrhages apparently due to relaxed fibre, rather than to an inflammatory condition of the mucous membrane. The indications for it are almost exactly those for ergot, as it presupposes an actual contractility of the uterine muscular fibre. Its advantages are: a quicker action than ergot, and the absence of the cramps that frequently attend the use of this drug. If the menorrhagic tendency, on the other hand, be accompanied by thickening and induration of the os and cervix, there is doubtless a cause for the extra flow in a morbid condition of the endometrium, which could be quickly removed by a few applications of the positive galvano-chemical cauterization.

The faradic current is applied to the interior of the uterus after the general method described elsewhere (page 82), the active pole being the intra-uterine electrode used in galvano-cauterization and the indifferent pole a large cotton pad on the abdomen or back. The negative pole of the rapid succession current is preferable, and I have obtained quicker responses from "swelling" currents—that is, currents increased and decreased every quarter of a minute, with the poles *in situ*. This last feature of the method is particularly effective in contracting unstriated muscular tissue.

The following cases exhibit the advantage of faradic over galvanic applications in recent hemorrhages:—

CASE XI. *Acute menorrhagia with relaxed uterus. Failure of two positive cauterizations to control flow. Complete arrest after one intra-uterine, faradic application. Subsequent lessening of hyperplasia by negative cauterization.*—R. A., married, aged 26, was seen in private practice, July 30, 1888. She had been perfectly well since last pregnancy, two years ago, until July 8th, when her ordinary menstrual flow came on as usual. This has continued ever since (twenty-two days). She loses much blood and has a great deal of pain. The patient was unable to assign a cause for her condition, which was possibly due to a miscarriage. The uterus measures three inches. Positive cauterization was used, eighty milliampères, for four minutes.

August 1st. Less pain, but only a trifling diminution of the bleeding. Positive cauterization, one hundred milliampères, for four minutes, was again used.

August 6th. The bleeding continues. A strong faradic current was now used for five minutes, with the negative pole intra-uterine.

August 8th. The bleeding ceased entirely on the afternoon of the first faradic application. The same current was again applied to reduce the size of the uterus.

August 10th. No bleeding. Pain about the back. Negative cauterization to reduce size, one hundred milliampères, three minutes.

August 12th. There has been but a slight discharge, due to the cauterization. Faradic current, five minutes.

The patient remained in excellent condition until her next menstruation, August 26th, which was so profuse that ergot was prescribed. This failed to control it

even with large doses, until, on the ninth day of the flow, the faradic current was again applied, followed by complete arrest in two hours. During the next intermenstrual period two positive cauterizations were made to reduce hyperplasia.

November 16th. Patient perfectly well. Menstrual periods last only four days.

CASE XII. *Acute metrorrhagia of abortion following a probable metritis. Bleeding not arrested by galvanic applications, but controlled by faradic current.*—R. T., aged 37, was referred by Dr. Bradford for treatment at the Pennsylvania Hospital clinic ten days after a miscarriage. She was the mother of eight children, and had had two miscarriages. Since the birth of the last child, thirteen months before, she had not felt well, and had been bleeding profusely since the miscarriage. Examination, October 4, 1888, showed os patulous, uterus enlarged, cavity three inches. Between that date and the 18th she was given one positive and two negative cauterizations, of a strength varying from twenty-five to one hundred and fifty milliampères. The bleeding continuing, a strong faradic current (negative intra-uterine) was given with immediate reduction. This was repeated October 20th. On the 23d she was entirely well, the cavity measuring two and a half inches, plus.

CASE XIII. *Recent exacerbation of long-standing menorrhagia. Temporary arrest after one positive cauterization. Complete arrest after one intra-uterine faradic application.*—Mrs. M., aged 33, three children, youngest two years old, applied to clinic at Howard Hospital in the fourth week of an attack of flooding. Menstruation regular, but profuse and painful, followed

by profuse leucorrhœa. Examination showed uterus normal in position, os patulous, cavity three inches, left ovary sensitive. Forty milliampères, positive, were applied to the cavity. Two days later she reported great lessening in the flow. On the fifth day the flow had returned worse than before. She was now given a powerful intra-uterine faradic application, which caused complete arrest. A month later she reported herself in the best of health.

Case XIV. *Metrorrhagia of three months' duration, following abortion. Failure of ergot. Complete cure after two faradic applications.*—Mrs. M. W., a young married woman with three children, appeared at the author's clinic at the Howard Hospital three months after a miscarriage, having been bleeding continuously since that occurrence, in spite of the efforts of three physicians, all of whom gave her large doses of ergot. On the day before application she had saturated six napkins with blood, and, besides the bleeding, was troubled with bearing-down pains and aching in the left groin. Examination disclosed nothing but a patulous os and a tender and relaxed uterus, which was not especially enlarged, and was freely movable. An intra-uterine swelling faradic application caused an appreciable diminution of the flow, and a second application two days later completely arrested it. There was no recurrence of any symptom.

The following case, nevertheless, proved an exception to the rules of current choice laid down above:—

Case XV. *Post-puerperal metrorrhagia of one month's duration. No effect from one faradic application. Arrest after one positive cauterizatien.*—Mrs.

S. B., aged 21, married two years, was seen at Howard Hospital clinic six months after the birth of a child. For one month there had been repeated attacks of uterine hemorrhage, accompanied by headache, derangement of stomach, and pain in both ovarian regions. Examination showed uterus in good position and freely movable, with a patulous os and tender body. Right ovary quite sensitive. A swelling intra-uterine faradic current was given, but two days later there was no change. A positive cauterization of sixty milliampères was now given for one minute, causing increased pain and flow for three hours, followed by complete arrest and disappearance of all symptoms. Subsequent health perfect.

Persistent Hemorrhages.—It is in the radical cure of persistent hemorrhages that Apostoli has led the way to most brilliant results, and in cases, too, that had been the opprobria of gynecologists. Others before him pointed out the hard slough at the positive pole of a destructive galvanic current, and noted also the readiness with which a retractile cicatrix followed the slough, but without his massive currents in association with the monopolar application the real value of this important remedy would have remained undiscovered.

The following cases were selected at the Pennsylvania Hospital out-patient clinic for a trial of the method :—

Case XVI. *Menorrhagia with a marked hyperplasia of six years' duration. Complete cure after eight applications.*—E. B., a Russian, aged 45, the mother of ten children, the youngest of which was seven, applied for treatment April 4, 1888. She had been ill six years, suffering from irregular and profuse menstruation, occurring every two weeks, excessive in amount and accom-

panied by severe pain in the back. Between the menstruations there was a constant white leucorrhœa. Patient weak and much reduced.

Examination revealed the os patulous and cervix much congested. The sound entered three inches, plus. She was treated by various means until June 7th without material alteration of her condition. On this date she was referred to the author by Dr. Bradford, and negative cauterization (in the absence of a proper positive electrode), thirty-five milliampères, was used for seven minutes.

June 16th. The day after application felt pains in uterus resembling labor pains. At the present time is free from pain and feels stronger.

June 23d. Negative application, twenty milliampères, ten minutes. Remains about the same. On the 26th her period came on, lasting four days.

July 4th. The uterus is decidedly smaller. An appropriate electrode having been obtained, positive cauterization was used, eighty milliampères, five minutes. This application caused some immediate pain.

July 14th. Hemorrhage ceased the day after last application. Positive cauterization, seventy milliampères, three minutes.

July 19th. After last application had slight bleeding. Positive cauterization, eighty milliampères, four and a half minutes.

July 26th. Since last operation has had no hemorrhage, and her general condition is much improved. Ordered to report weekly for inspection.

Her next menstrual period appeared July 27th, just one month and a day from the last. The duration of this period was but five days. There was no leucorrhœa

subsequent to it. The next two periods were exactly a month apart and normal in every respect. On September 28th the patient returned, complaining of pains in the back and limbs; there had been no discharge. Positive cauterization, two hundred milliampères, was applied four minutes. A subsequent study of the case proved that this application was entirely too severe considering her improved condition. It was followed by pain and a brownish discharge, lasting six days.

During October two applications of fifty milliampères each were given, the general condition improving.

November 13th. Her daughter states that the patient is feeling much better. The full four weeks between her periods continued without bleeding or discharge of any kind. The last menstrual period was unattended with the pain that had formerly troubled her. Discharged cured.

Case XVII. *Menorrhagia of five months' duration following miscarriage. Complete cure accomplished by the use of three positive cauterizations.*—Agnes Sharp, married, aged 22 years. No children; one abortion. Five months ago, while lifting a heavy tool-chest, became sick and aborted a six weeks' fœtus. Since then menstruates every three weeks, losing a large quantity of blood for four days, accompanied by much pain. Has a constant leucorrhœal flow of large amount, white and tenacious, attended with pain in left ovarian region. Examination reveals uterus small, position normal, os small, vaginal surface healthy. Sound enters two and a half inches and reveals a tender fundus.

September 18, 1888. Positive cauterization, forty milliampères, four minutes.

September 20th. Positive cauterization, forty milliampères, four minutes. There has been no pain since the day after first treatment.

September 22d. Slight brownish discharge on the day after last application. To-day is feeling well. No treatment used.

September 25th. Felt well until yesterday, when she had some pain. Positive cauterization, forty milliampères, four minutes.

October 9th. Menstruation appeared October 1st, lasting four days, with lessened pain. Is now free from any discharge. No treatment. To return next month.

November 1st. Menstruation appeared October 28th, lasting three days. Is entirely well at the present time.

CHAPTER XIII.

THE ELECTRICAL TREATMENT OF SUBINVOLUTION.

In the subinvolutions unaccompanied by striking hemorrhage, due to instrumental labors, miscarriages, and other causes of post-puerperal inertia, an intra-uterine application of electricity is fully as useful as in hemorrhagic cases. In recent conditions of relaxation or engorgement the faradic current is quite sufficient. Tripier and Apostoli, indeed, have recommended the systematic employment of this agent as a prophylactic in all puerperal cases, but the author has a decided preference for nature's methods of accomplishing the same result by the association of drainage and absorption with the contraction. When the proper period for non-interference has passed it is time enough to call upon art.

In more chronic cases of subinvolution or hyperplasia, when a lowly-organized connective tissue displaces the uterine muscle, faradic currents will be found much less useful than galvanic. A single pole of either current is the method usually employed by the author, but some recommend a bipolar intra-uterine electrode for the faradic current in preference to the monopolar method. The following cases bear a similar testimony to those cited in the preceding chapter:—

Case XVIII. *Recent subinvolution. Reduction to normal condition after five faradic applications.*—Mrs. J. S., æt. 26. Seen with Dr. Bradford at the Pennsylvania Hospital. She had had two children and two miscarriages, the last but ten days before her appearance at

the clinic, and was complaining of pain in the back and tenderness over the whole abdomen. The uterine cavity measured four inches. Lochial discharge present. On this day an intra-uterine negative faradic current was given. Three days later she felt better, and the cavity was but three and a half inches. The treatment was repeated on this occasion, and again on three subsequent occasions. After the fifth application the cavity was but two and a half inches and the abdomen was no longer tender.

CASE XIX. *Recent subinvolution. Complete relief in seven days.*—Mrs. J. McL., a young married lady, was seen October 21, 1889. A still-born child had been delivered instrumentally two months before. She had menstruated profusely two weeks after confinement and again a month later, and was troubled with leucorrhœa and pain in the right hip and back. Examination showed some bleeding, uterus well placed and movable, cervix short, os patulous, cavity three and a half inches. She was given a powerful faradic monopolar application to cavity.

October 23d. Flow continues intermittently. Cavity reduced to three inches. Faradic application repeated.

October 25th. Slight flow continues. Cavity three inches. Positive cauterization of cavity, seventy-five milliampères, one minute, followed by faradic current.

October 28th. No hemorrhage since last treatment. Cavity two and a half inches. Feels perfectly well.

A month later she reported a continuance of good health.

CHAPTER XIV.

THE ELECTRICAL TREATMENT OF CHRONIC METRITIS AND CHRONIC ENDOMETRITIS.

Apostoli has recently called attention to the value of negative cauterization in the chronic catarrhal diseases of the endometrium.* Before the issue of his address upon the subject the author was convinced of the value of this application in those cases in which local treatment is imperative, and had been using it in doses of ten to thirty milliampères with most satisfactory results. This justly celebrated clinician was, however, led to the use of much stronger doses (eighty to two hundred and fifty milliampères) as the result of observations made upon this condition while treating fibroid tumors. Incited by his enthusiastic commendation, I have recently put the method to the test of a large number of cases, and, although rarely using more than fifty to seventy-five milliampères, have obtained results that almost warrant for it the claim of infallibility. Some of its advantages are: Ease of application, controllability, combination of a contractile action on the uterus with the local effect, and speedy results.

We have in these cases all shades of deviation from a normal mucous membrane, varying from a hyperæmic catarrh, with little or no change in the membrane, to a granular and eroded surface, with involvement of the Nabothian glands in the cervix, and infiltration of the

* "A New Treatment of Chronic Metritis," by Georges Apostoli.

fibrous tissue of the body and neck. In the milder forms, evidenced mainly by a leucorrhœal discharge from the cavity of the neck or body, the milder therapeutic application of ten, fifteen, or twenty milliampères, negative, directly to the diseased part will frequently check a persistent discharge after two or three treatments. The following case does not differ materially from a number of similar instances observed :—

CASE XX. *Endometritis with moderate hypertrophy of six months' duration. Complete relief from discharge and subjective symptoms after three very mild negative intra-uterine cauterizations.*—Mrs. A. W., aged 32, consulted me March 28, 1888. Six months before she had caught cold when moving, and had suffered from leucorrhœa, headache, backache, and difficulty in walking ever since. At this time could go up-stairs only with great deliberation, owing to pain in stomach and back. On examination, the os was found to be patulous, with firm lips; uterus slightly enlarged; cavity, two and a half inches, plus. A negative galvanic application of ten milliampères was made to cavity for ten minutes. Two days after (March 30th) she returned with the report that the leucorrhœa had ceased after her first visit, and that her head was much better. On this day she was given twenty milliampères, for ten minutes.

April 5th. Negative application, ten milliampères, ten minutes; uterus softer. Headache has ceased.

April 8th. Negative application, ten milliampères, ten minutes.

April 11th. Reports herself entirely well. The headache, mental confusion, and backache have entirely disappeared, and she can now ascend and descend the stairs

with comfort. The os is less patulous, but the uterus remains larger than normal.

October 18th. Has remained free from leucorrhœa. Examination shows uterus enlarged, but, as she says she is well, nothing further is proposed.

In considering the apparent mildness of the applications which accomplished these marvelous results, we should not be led to think too lightly of the stimulating and alterative power of ten milliampères of current when concentrated on the small surface of electrode in contact with the cavity. The same amount of current concentrated to a similar surface contact on the exterior of the body would not only produce considerable pain, but a decided disturbance of the vascular supply of the surface also. This sensory disturbance is, of course, absent in the uterus, but the vascular irritation is doubtless more pronounced.

With distinctly hypertrophied and degenerated tissue surrounding the uterine cavity and outlet the problem is different. Here a stimulation of the diseased layers must precede their regeneration, and a scientific agency that will accurately and aseptically dissolve the morbid secretions, while at the same time stimulating a healthy reproduction, is a radical measure that commends itself even to the conservative mind. Such a surface-dissolving agency we possess in accurately measured and timed negative cauterization, which, strictly localized to the diseased part by recent methods, constitutes the most scientific and rational application that could possibly be conceived. In cauterizing the tissue, it adds no new elements of a foreign character to it to act subsequently as irritants, but simply breaks up the tissue itself into

its chemical components, and those left about the negative pole are quickly drained away or absorbed. The only disadvantage of the negative cauterizations is the sanguinolent discharge that flows from the dissolved edges. In cases with hemorrhagic tendencies this may occasionally give trouble.

This new electrical treatment of the conditions formerly regarded as "erosions" and "ulcerations" is, of course, a development of the older application of cup-shaped electrodes to the os, just as intra-uterine swabbing developed from the lunar caustic stick applied to the same part, but it is in an additional sense an advance on earlier methods by the adoption of accurate mensuration and control.

With its incalculable usefulness in the cure of morbid conditions of the endometrium, even including early malignant disease in this situation, we should not fail to remember a possible danger arising from overuse. A heavy cauterization, with one hundred to one hundred and fifty milliampères, lasting some minutes, is highly appropriate in the graver cases, especially those accompanied by hyperplasia, but is not to be thought of in cases of mere catarrh, when ten to fifty milliampères can be made to answer.

Not a little care should be bestowed also on the frequency of application in such cases, and in waiting for full results after a moderate number of applications have been made. Twice or thrice a week during one intermenstrual period will frequently cure an uncomplicated case.

Where the appearance of the cervix and the nature of the discharge indicate merely an endocervicitis, the

electrode should be insulated to within one and a quarter inches of the end, and only the bare portion inserted within the canal.

The following cases illustrate the treatment of these conditions with strong currents :—

Case XXI. *Chronic, purulent endometritis of five years' duration. Complete relief after eight negative cauterizations.*—E. L., married, aged 37, was seen first in private practice early in March, 1888. She had suffered from hemorrhage five years before, which had left her with a constant, abundant leucorrhœa of a greenish-white color and offensive odor. Menstruation was regular, abundant, and attended with considerable pain. Examination showed an eroded os with thickened lips. Uterus two and a half inches, plus, anteflexed, and slightly hypertrophied. At this visit, thirty milliampères, negative, was applied to the endometrium for five minutes. The odor from the discharge was so offensive as to necessitate opening the office windows.

March 12th. Discharge clearer and less abundant. Negative cauterization, eighty milliampères, four minutes.

March 16th. Electrode introduced with greater ease. Negative cauterization, one hundred milliampères, four minutes.

March 18th. Negative cauterization, one hundred milliampères, four minutes. Discharge clearer and much less offensive.

March 20th. Negative cauterization, eighty milliampères, three minutes.

Her menstrual period followed several days later, normal in amount and duration, and attended with less

pain than at any time for years. Several similar applications were made during the next intermenstrual period, when it was noticed that the discharge was much lessened in amount and entirely free from odor. The second intermenstrual period was free from discharge of any kind. Eight months later the patient was seen, and stated that she had remained entirely well since.

CASE XIV. *Endometritis, with bilateral laceration of cervix, eroded os, and menorrhagia. After seven cauterizations the os and cervix present a normal appearance.*—S. M., a married woman, aged 42, referred by Dr. Bradford at the clinic of the Pennsylvania Hospital. She had had seven children and one miscarriage of a six months' fœtus, the latter occurring two years ago. The patient was in the House Department of the Hospital, and sent to the dispensary by the courtesy of Dr. Westcott, who suspected a malignant disease of the cervix. Menstruation very profuse, returning every three weeks. On examination, the os shows bilateral laceration, with the anterior lip so greatly enlarged and eroded that a malignant growth was thought probable. Uterus hypertrophied; sound enters three inches, plus, through a patulous os.

July 19, 1888, treatment begun. During the ensuing month she was given one negative and three positive cauterizations of seventy to one hundred milliampères.

August 21st. She reported feeling better than for a long time. During September three additional positive cauterizations were given, of one hundred, one hundred and fifty, and sixty milliampères. At the latter date the os and cervix were firm, and nearly normal to both sight and touch.

CASE XXIII. *Chronic metritis of five years' duration. Reduction to normal size and disappearance of symptoms after five applications to cavity.*—Mrs. M. S., aged 38, mother of one child 10 years old. Five years ago had a miscarriage and has been ill ever since. Suffers from pain in the right groin, which is sore and tender to touch. Menstruation every three weeks; flow normal, with severe bearing-down pains. Has a continuous intermenstrual backache and leucorrhœa.

Examination November 25, 1889, showed an enlarged and prolapsed uterus, adherent to the right. Manipulation caused considerable pain. Os eroded and exuding muco-purulent matter; cavity three and a half inches. Forty-five milliampères, positive, were applied to the cavity for two minutes.

December 9th. Soreness and backache better. Positive cauterization of cavity, forty-five milliampères, one minute.

December 27th. Menstrual flow since last treatment unaccompanied by pain for the first time in five years. Cavity three inches. Positive cauterization, forty-five milliampères, two minutes.

December 30th. More pain than usual. Positive cauterization, forty-five milliampères, two minutes.

January 3, 1890. Uterus in normal position and freely movable, with but slight pain. Shortening and slight thickening in region of right broad ligament. Cavity two and a half inches, but some leucorrhœa continues.

January 17th. Menstruation at third week, again painless. Leucorrhœa slight. Positive cauterization, twenty-five milliampères, two minutes.

January 27th. Leucorrhœa more watery. Positive cauterization, forty milliampères, three minutes.

February 10th. Menstrual flow normal and painless. Cavity two and a half inches. No leucorrhœa since last period.

CASE XXIV. *Chronic metritis of two years' duration. Complete relief after three applications.* Mrs. M. H., aged 31, was seen at Howard Hospital in July, 1889. She had had eight children and one miscarriage, the latter two years before, since which she had been ailing. Pain in back, left side, and head, with abundant leucorrhœa. Walking difficult. Examination: Uterus hypertrophied, os slightly lacerated, cavity three inches, purulent discharge from uterus. Tenderness in both ovarian regions. She was given three negative cauterizations of fifty milliampères each at intervals of one week. After the next period she reported complete relief of all symptoms, and the cavity was found to be but two and one half inches.

CHAPTER XV.

THE ELECTRICAL TREATMENT OF CHRONIC INFLAMMATORY DISEASES OF THE UTERINE APPENDAGES.

THE judicious use of electrical currents is destined to play an important part in the treatment of ovarian and tubal inflammatory troubles in the near future. With a reckless disregard of the remote effects of removal of these important organs, both physical and mental, a school of young surgeons has recently arisen whose principal ambition seems to be to increase their list of laparotomies. After a superficial examination, and without even making a diagnosis, they immediately proceed to perform an operation which results only possibly in a continuance of life and relief of the trouble, though certain to unsex the woman and leave her a prey to the mental degenerations that seem to follow oöphorectomy. The extravagance of this position will work its own downfall. That ablation or amputation is the only resort worthy of a surgeon is certainly a novel proposition, and admittedly untenable in reference to any other part of the body; until they demand removal of the testicle for every case of orchitis or epididymitis we should look upon their present position with suspicion. A conservative reaction from this war-time in abdominal surgery may be predicted with confidence.

That a removal of the appendages is occasionally required is very certain, but the author is not prepared to believe that the thousands of cases annually

reported present conditions that bring them within this class.

Concerning the electrical treatment of ovaritis, salpingitis, and allied conditions it may be said that by this means a large proportion of the cases are absolutely and permanently curable. The necessity for patience and time in some cases is pronounced, but when we consider the importance of the results these should not be grudgingly given. Other cases are quickly cured, particularly those presenting symptoms of ovarian congestion bordering on ovaritis, but it is only reasonable to suppose that such speedy results are an indication of but slight structural changes.

In spite of the dogmatic assertions of many the difficulties surrounding the differential diagnosis between ovaritis, salpingitis, parametric inflammation with cellulitic deposits, and early extra-uterine pregnancy is very great. That an abdominal section should be performed for the purpose of settling the diagnosis is nevertheless monstrous. Not one of these conditions will be aggravated by vaginal monopolar applications of the galvanic current, but, on the contrary, a number of cases, notably of ovaritis and cellulitic deposits, will be benefited and finally cured by it. The existence of pus in a tube or elsewhere in the pelvis may be a contra-indication to this form of electrical application, but if so I have never had evidence of the fact. In Case XXVII a pus-tube was unquestionably emptied by an *intra-uterine* application with immediate relief, but it is not my usual practice to use the current to the cavity in cases of diseased appendages or of parametritis unless the evidences of an associated chronic metritis are pronounced, and not then before the

surrounding inflammation has been greatly reduced by preceding vaginal applications. When these conditions are semiacute it is well known that any intra-uterine interference is liable to cause an aggravation and intra-uterine galvano-chemical cauterization is probably no exception. While this is so, I have frequently found a period in the treatment when a few judicious though strong applications to the cavity (seventy-five to one hundred milliampères) followed by prolonged rest to be the one thing needful in completely curing the case, for we should not neglect the fact that the endometrium in many cases is the primary seat of the disease.

I have had no experience with the faradic current in inflammatory conditions of the appendages, preferring the galvanic current instead.

CASE XXV. *Ovarian congestion of aggravated type. Complete restoration of health after seven weeks' external treatment.*—Miss X. Y., aged 21, a young lady from a neighboring State, was referred to the author by Professor Pepper. Since puberty she had suffered from menorrhalgia until about one year before being seen. At that date the menstrual pain abated on the appearance of a continuous intermenstrual pain and tenderness in the region of the left ovary, which presented a distinct swelling. The pain became so bad as to cause a continuous insomnia that resisted large doses of anodynes and impaired her health so materially that her attending physician seriously considered the advisability of Battey's operation. She was admitted to the author's private sanitarium, February 23d, 1889, and, after a verification of the diagnosis of an enlarged left ovary, was placed on percutaneous galvanic currents passed from the in-

tegument over the ovary to the sacrum, together with general faradic stimulation and massage. She improved immediately, the swelling disappearing in the course of four weeks, and at the end of seven weeks she was discharged in perfect health and with a decided increase in weight.

In the more serious ovario-tubal inflammations of married women, on the other hand, the history is by no means so succinct. Here long-continued treatment is often the price of success, and in the case of such poor, hard-working women as in the following instance it becomes a serious question whether removal of the appendages would not be best. The history illustrates, nevertheless, what can be done, even under the unfavorable circumstances of a woman compelled to do all the work of a large family:—

Case XXVI. *Prolapsed ovary surrounded by adhesions and indurations of four years' standing. Uterus hypertrophied, displaced laterally, and exquisitely sensitive. Complete relief after five months' treatment, followed later by relapse.*—E. C., aged 26, married, a native of Poland, was seen, with Dr. Bradford, at the Pennsylvania Hospital clinic. She had had three children and one miscarriage, the last pregnancy four years ago, since which time she had been in continuous pain and had grown progressively worse. For the last four weeks has been particularly bad, a sanguineous discharge having been constant. There is absolute dyspareunia, and any jar causes intense pain. Menstruation has been regular, normal in amount, attended with severe floodings after pain, followed by scanty, yellow leucorrhœa. She had declined operation.

Examination showed uterus enlarged, somewhat anteflexed, and with fundus displaced to the right. Sound enters three inches with difficulty, producing excruciating pain. To the left of the fundus a mass is made out, consisting apparently of the ovary bound down by adhesions. The patient's physiognomy indicated intense suffering at every step. Treatment: positive cauterization to the cavity, forty milliampères, three minutes. This was subsequently increased gradually to seventy milliampères to check hemorrhage and reduce the uterine hypertrophy. After the third application she felt much better and had no further hemorrhage. After the tenth application, which had been progressively reduced in strength until but ten milliampères were given, she had no pain whatever, the uterus measured but two and a half inches, and the mass to the left was scarcely discernible. At this time a very severe examination was required to give her pain and the treatment was changed to negative vaginal applications of thirty to fifty milliampères, which was kept up at intervals for about three months, making the treatment five months in duration, at the end of which time she was discharged practically well. Four months later she was seen by appointment, and it was learned that she had continued to feel even better, having maintained marital relations without pain and done all the work for a large family. Examination, which was made in the presence of Dr. J. M. Baldy and was verified by him, showed the uterus normal in size and freely movable with some pain. Fundus in a normal position. A mass resembling a tube is still felt on the left, but gives no pain on pressure. She was rosy and hearty, and claimed to be entirely well.

A month later it was learned that this case had a slight relapse, and three months later a severe one, doubtless due to excess and bad personal hygiene.

This case may yet be compelled to submit to the knife, owing to the impossibility of securing the proper adjuncts to treatment, but the two following cases are a distinct refutation of the claim that operation alone can cure this condition:—

CASE XXVII. *Inflammatory disease of uterus and appendages, with probable pyosalpinx. Three negative cauterizations of the uterine cavity, and four negative vaginal applications. Profuse discharge, probably from tubes, after third intra-uterine application, followed by complete recovery and subsequent pregnancy.*—Mrs. K. D., aged 28. Was regular until her only pregnancy, five years ago, since which time she has felt badly, having a sharp pain in both ovarian regions, with a sensation of something falling. Menstruation irregular and flow slight. No leucorrhœa. Examination showed enlargement and fixation of uterus, and fullness in region of both broad ligaments. Condition verified by Dr. Constantine Goodell. She was placed upon negative vaginal applications, thirty to forty milliampères. After the second visit a considerable intermittent leucorrhœa was noted, and the uterine surroundings were less boggy, showing cellulitic deposits more plainly. The cavity was now ascertained to be three inches, and was cauterized with thirty-five milliampères, negative, repeated five days later. After the second cauterization an offensive, chocolate-colored discharge appeared, followed by menstruation, and later by a watery discharge. A third intra-uterine negative application of thirty-five milliampères was followed by cramps

and an intermittent copious discharge of pus, evidently from the tubes, followed by immediate relief of pain and all symptoms. Subsequent health good. Duration of treatment three weeks. As a proof of a practical restoration of function in the tubes and ovaries of this patient, she became pregnant two months after the cessation of treatment.

CASE XXVIII. *Salpingitis of one year's duration. Recovery after eight negative vaginal applications, followed by immediate pregnancy.*—Mrs. S. J., aged 32, four children, three miscarriages. Has been in bad health since birth of last child, one year ago. Three weeks after confinement had an abscess opening into vagina, and has been suffering with bearing-down sensations and pain on micturition, and in left groin and back since. Menstruation regular and without much pain. Leucorrhœa abundant at times, white, and tenacious. Examination showed perineum intact; uterus well forward and adherent to left. Left tubal region boggy and tender. She was placed upon negative vaginal applications of sixty milliampères, three minutes in duration, twice a week. There was a progressive improvement, and she was well after the eighth application. Cessation of treatment was followed by a prompt conception, and when patient was last seen she was five months pregnant.

The method of treatment adopted by the author, it will be noted, is that of a direct correction of any existing endometritis in all cases when possible, associated with, and generally preceded by, vaginal applications. This is also the method of Apostoli, with the addition of painless faradic currents for the more acute symp-

toms and vaginal galvano-puncture for the more obstinate cases of hydro- and pyo- salpinx. This author's latest deliverance upon this subject is contained in an extremely interesting introduction to Bigelow's "Gynæcological Electro-Therapeutics." Special care is advised in reference to the intra-uterine applications in avoiding acute conditions and too frequent treatment. Puncture is indicated when the intra-uterine applications fail, his patients affirming that, though the punctions are more painful, they are much more efficacious, because one punction alone often gave more comfort than many intra-uterine applications. It is also indicated when a fluctuating tumor presses into the vagina and demands rapid evacuation. One-half a centimetre only is advised, deep punctures being dangerous, the patient being in bed and placed on antiseptic precautions.

FIG. 37. GOELET'S TROCAR AND CANULA.

Goelet uses a trocar and canula (Fig. 37) somewhat similar to Gehrung's, with the difference that it is but one way, and is made of platinum to fit it for use as a positive pole. The instrument represented in the cut has a platinum canula of No. 4 French catheter-scale. The shaft is covered with an adjustable sheath, *A*, of hard rubber for insulation. This may be fixed at any point by the screw, *B*, and the degree of penetration limited. At *C* there is a three-way stop-cock, and at *D* a connection for an irrigator, as well as a socket for

is exceedingly striking. The only proper methods of treatment are those directed to the cure of the causative conditions, full details of which may be found elsewhere under appropriate headings.

2. **Menorrhalgia.**—*Menstrual pain; dysmenorrhœa.*—The list of pathological views that have been advanced in accounting for what is usually called dysmenorrhœa is somewhat extended, even when the term is restricted to the uterine type of painful menstruation, excluding ovarian and inflammatory pains and true neuralgia. Those most prevalent at the present time are, on the one hand, the mechanical theory of obstruction from stenosis or flexion, which may be called the Marion Sims theory, and, on the other hand, the parametritis theory of Schultze. As to the first, it is not sufficiently well known that this latter observer has completely upset the obstructive or mechanical theory by demonstrating that a sound may be passed during the crisis of a supposed example of accumulation without encountering fluid. Such a theory is also weakened by the examples of stenosis and anteflexion that occur without painful menstruation. Yet Schultze's theory of para- or peri- metric inflammation as a cause is not by any means satisfactory. That it has failed of practical acceptance by those even who advocated it is shown by their adherence to dilatation as a means of cure.

In that excellent picture of painful menstruation contributed by W. Gill Wylie to the "American System of Gynecology," another pathological condition is suggested—hyperæsthesia of the endometrium. That an hyperæsthetic condition of the cavity does exist in these cases, I think any one who has passed a sound into them

will admit. The exclamations of pain when the internal os is passed are most characteristic, and, in cases where a proper gentleness has been observed, must be other than normal; yet there are certain facts which indicate that hyperæsthesia is but one of the conditions present. In a typical attack of painful menstruation the first thing to appear is the pain, which precedes the flow by an appreciable interval. How a mere hyperæsthesia of the endometrium can explain this does not appear clear. In the great majority of such cases the pain ceases, in part or altogether, after the flow has been established, and it is this fact particularly which has intrenched the believers in the purely mechanical or obstructive nature of the trouble, which, in its boldest form, attributes the pain to a damming up of the menstrual fluid by a too narrow outlet, through which it is forced by a "mimic labor." To Schultze's demonstration of the absence of an accumulation, which is corroborated by an absence of dilatations above the alleged stricture, may be added another argument against this latter view, in the fact that analogous conditions of stricture, as in the male urethra, are not attended by premonitory pains, but by greatest pain during the actual flow. The "mimic-labor" illustration is inappropriate for the same reason. Finally, the non-existence of a fibrous mechanical stricture is proven by the fact that ether will relax the apparently stenotic internal os sufficiently to permit a large dilator to be inserted.

A better explanation of the etiology of painful menstruation is that which regards it as almost entirely a neuro-muscular phenomenon. The attempt at the performance of an important function while either the nerve-

centres in the cord or the uterus itself are in an unprepared condition results in pain. If the trouble is in the uterus the pains assume a nature that the patients themselves have accurately described as "cramps." In a paper read before the Philadelphia Obstetrical Society, December 5, 1889, the author proposed for this condition the name of a *menorrhspasm.* That the spasm alone is the parent of the pain rather than retained excretion is more than likely, an associated sequence being an inhibition of the excretory act until relaxation has occurred.

Menorrhspasm, in brief, may be said to be a neuromyotic storm of the uterine neuro-muscular apparatus, which renders the excretion of the menstrual fluid temporarily impossible. Its exciting cause may be either lack of development of the organ or morbid conditions of the endometrium, while its remote causes are traceable to all those influences in modern society which hinder the proper development of animal life in young women.

That a spastic muscular contraction, most noticeable at the internal os, usually accompanies the menorrhspasm is undoubted, and there is reason to believe that the contraction may be excited by the sound between periods. The predominance of circular fibres at the internal os, which is clearly shown in the accompanying cut (Fig. 38) from Barnes' "Diseases of Women," offers a ready explanation of this.

If such views of this condition are correct, it becomes evident at once that a better name than *dysmenorrhœa* (difficult menstruation) should be used in describing it, particularly since this term at once suggests mechanical conditions only, with the harsh treat-

ment appropriate to such. At the meeting referred to, the author, while advocating the view that the causative condition was a menorrhspasm, urged the general use of the merely symptomatic designation, *menorrhalgia* (menstrual-flow pain) in preference to dysmenorrhœa, as, in itself, involving no theory.

Accepting the neuro-muscular view of the cause of these pains, the oneness of the pathological condition in all cases is at once apparent, the differences being only matters of degree. In the one case, the neuro-myotic storm is but a danger-signal pointing to a neurotic con-

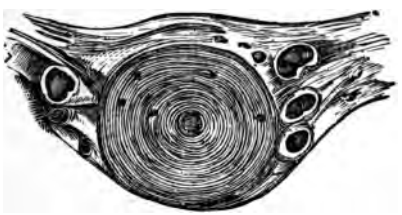

FIG. 38.—SECTION OF UTERUS MADE AT OS INTERNUM (ad nat.), showing the normal size of the os internum, the circular disposition of the fibres around it, and the blood-vessels in proximity. (*Barnes.*)

stitution, vasomotor disturbances, spinal irritation, abdominal torpidity, or even merely habitual constipation; the attempt at the performance of a high function in the presence of these disabling conditions resulting in pain. Given a high degree of uterine neuro-muscular incapacity and the spastic spasm occurs in the absence of these allied conditions, rendering direct local treatment imperative for its relief.

We have, then, a simple and convenient division of cases of menorrhalgia into those not requiring local treatment and those in which local treatment is neces-

sary. The dictates of common sense unite with the high obligations of the physician in urging him to assign all cases of menorrhalgia in virgins to the former class, at least until he has demonstrated by a failure of general methods that a local examination is imperative. The author cannot too strongly condemn the general habit of hasty examination in these cases,—a habit that is a direct sequence of the ultra-mechanical views of the day.

Menorrhalgia of the lesser degree, and even the most painful form, when accompanied by derangements of the nervous system or of the abdominal viscera and unaccompanied by organic uterine disease, is best treated by percutaneous galvanic applications, abdomino-dorsal, or even merely spinal, the dose varying from ten to sixty milliampères, *pro re nata*. Large, well-moistened electrodes, and the gradual manner, without shocks, should be used. The following cases may be taken as illustrations, the one first cited being the means of originally directing my attention to the value of the constant current to the spine in this complaint:—

Case XXIX. *Menorrhalgia of some years' duration. Relief under spinal galvanic applications.*—Miss S. F., æt. 30, received eight applications of the continuous current to the spine at the electrical clinic of the Orthopædic Hospital, during a period of two months, for a nervous affection. During this time she reported to me that her menstrual periods, which had given her pain for years, no longer troubled her, and that there was also an increased flow. This was before the days of the meter, but the current strength was probably in the neighborhood of twenty milliampères, with the positive

pole at the nape of the neck and the negative at the lumbar region.

CASE XXX. *Menorrhalgia and lateral sclerosis. Lessened pain under spinal applications.*—M. McB., æt. 20, was receiving triweekly applications of the galvanic current to the spinal region for pronounced spastic paralysis. After several months' treatment she volunteered the statement that she had less pain at her periods. Her weight also began to increase at this time, gaining three pounds in two months.

CASE XXXI. *Menorrhalgia with scanty flow. Complete relief under spinal applications.*—Miss K. S., æt. 18. Began menstruating at sixteen. The flow had always been scanty and attended with pains across the back. Weight, ninety pounds. The constant current was applied to the back every other day, as described, the situation of the electrodes being so shifted as to include one region after another in a stabile action. The next period was painless and showed an increased flow. At the end of a month the weight had increased to ninety-five pounds. The treatment was discontinued as succeeding periods were almost entirely free from pain.

CASE XXXII. *Menorrhalgia persisting after pregnancy. Improvement under spinal galvanic applications.*—Mrs. E. S., æt. 22, who had been under my care for ovarian pains, returned six months after the birth of her first child, suffering from an aggravation of a dysmenorrhœa that had troubled her throughout her menstrual life. The cervical canal was patulous, and uterus normal. Applications of the constant current to back were made twice a week for two months, with

were made, followed by a perfectly painless period. Six months later the patient reported perfect health and continued immunity from pain.

CASE XXXIV. *Menorrhalgia and endometritis, aggravated by marriage. One mild cauterization, followed by pregnancy and subsequent good health.*—Mrs. S. Z., aged 26, married six months. Since puberty has had menorrhalgia, the periods appearing every five weeks and lasting three weeks. During the first week has pain only, with free flow and clots during the second and third weeks. Leucorrhœa remaining a week, white and voluminous. Walking almost impossible. Examination showed uterus low, virginal, retroverted but movable. Sound inserted to normal depth with much difficulty. She was given an intra-uterine negative application of twenty-five milliampères, five minutes. This was followed by relief of pain. A month later she became pregnant, and was delivered at term of a healthy boy. Subsequent menstruation normal and painless.

CASE XXXV. *Menorrhalgia and endometritis of three years' duration. Great relief after one premenstrual positive cauterization. Complete relief after four applications.*—Mary R., aged 32, married. Had had one child; no miscarriages. Since birth of child, three years ago, has had severe pain during menstruation, beginning two days before appearance of flow. The discharge is slight and pale for one day and more abundant subsequently, accompanied by large, firm clots. The periods appear sometimes twice a month, are excessive in amount, and painful throughout. Has moderate amount of leucorrhœa, yellow in color. Has intermenstrual

pain in sacral region, but locomotion is not affected except immediately after menstrual period.

Examination revealed a stellate laceration of the cervix, movable uterus, and os covered with a profuse discharge. Sound enters three inches plus. She was given a positive cauterization of cavity, seventy milliampères, four minutes. Two days later the menstrual flow appeared, and was less painful than at any time for three years. During the next intermenstrual period she was given three additional cauterizations of sixty-five and sixty milliampères, the second period appearing at the fourth week, normal in character, and with but slight pain. The cavity was now ascertained to be but two and a half inches. Subsequent inquiries showed a continuance of regular and painless periods.

3. **Intermenstrual Pelvic Neuralgia.**—A persistent pain in the groin or iliac region, unassociated with other evidence of disease in the organs accessible to examination, may be safely ascribed to a neuralgic affection of the nervous supply of the pelvis. Much attention has recently been bestowed on the causal relation of normal and diseased ovaries to this pain, and a great mass of operative experience has accumulated to shed light upon the subject. As an observer of these cases after the performance of laparotomy, I am inclined to think that only those are bettered in which unequivocal evidence of organic disease existed prior to the operation, or in which a hysterical condition predominated, rendering the patient amenable to the profound mental impression of the procedure. It is not rational to expect to cure a more or less intense *neuralgic* pain in this region, even when it is apparently situated in the ovary itself, by a

removal of this organ, for no analogous operation in any part of the body is attended by such results. It should be remembered that the ovarian nerves *terminate* in the ovary, and their removal is no more likely to cure the pain than is removal of the teeth of the lower jaw for neuralgia of the inferior dental nerve. If the nerve-trunks concerned in the pain could themselves be exsected, there would be a certain relief for some months or years, at least, as has been well proven by operations on the nerve-trunks of the face. A close examination of many of these cases of pelvic neuralgia will show that strictly neuralgic pain is rarely situated in the ovary. It is more often in the lower portion of the abdominal cavity, in the pelvic bone, or in the anterior crural distribution on the thigh. Tenderness, on the other hand, is more likely to be limited to the ovary itself or to the nerves in its close proximity.

Unfortunately, the electrical treatment of the graver cases of pelvic neuralgia is no more likely to permanently cure them than is oöphorectomy. Such cases are closely analogous to the worst forms of *tic-douloureux*, and, like them, are likely to remain among the opprobria of medical science. While this is true of the more profound neuralgias of this region, as of others, it is also a fact that there are very few cases that are not more or less benefited by the systematic employment of the galvanic current through the skin or of vaginal faradic applications, some cases being undoubtedly cured. The method best adapted to the purely neuralgic type is the abdomino-dorsal application (p. 103), the negative pole being anterior.

There are also less profound neuralgic conditions

(and these make up the bulk of the cases) in which the pain is strictly limited to either the ovary or its immediate neighborhood—cases of true overalgia, which, when associated with tenderness, are frequently mistaken for ovaritis. These cases, as a rule, are quickly relieved and cured by either abdomino-lumbar or vagino-abdominal applications of either current, accompanied by proper regulation of the bodily functions. It is possible that a subacute ovaritis does at times exist and yield to the treatment, and certainly none better could be thought of.

The possibility of a neuralgic condition in the pelvis being due to disease of the cord should never be lost sight of. Gynecologists are too prone to forget that the pelvis is supplied with spinal nerves almost as richly as any other part of the body, and that it may be the seat of pains due to systemic diseases of the cord, localized meningitis, etc. I have observed evidences of one or another of these conditions in several cases referred to me after the removal of normal ovaries, the pain that the laparotomy was designed to cure still persisting. The failure of this operation to relieve the pain is, under such circumstances, inevitable. One of these cases was so striking as to deserve relation in detail:—

A young married lady from a Western city consulted me several weeks after one ovary had been removed by an eminent operator in New York City. Previous to the operation, it was said that a small tumor was diagnosed, but the section only revealed an enlarged ovary, which was removed. The condition which the operator sought to relieve, and which still persisted, was a stiffness of the lower limbs that almost amounted to an inability to

walk, and a more or less continuous pain in the left ilium. She had been in this condition fifteen years, having been at first totally paralyzed in the lower limbs. During these years she had borne several healthy children, and the singular part of the case was that she walked well and was free from pain during each pregnancy, and to a much lesser extent during each menstrual flow. At this time her uterus was normal, with merely some relaxation of the vagina.

An examination of the lower limbs showed a decided spastic condition, with exaggerated patellar phenomenon, foot-clonus, and contractures of the calf-muscles. The limbs were slightly atrophied, but responded well to both currents. It was clear from these facts, and the absence of pressure symptoms as shown in the electrical reaction, that pelvic pressure or irritation was guiltless of a causative relation to the case. The symptoms pointed clearly to an organic change in the lateral columns and meninges of the lumbar enlargement of the cord.

The moral to be drawn from cases such as this is a forcible one. We should be exceedingly distrustful of hasty diagnoses when dealing with persistent pains in the pelvic regions as in any other part of the body, and should not fail to employ the more simple neurological means of examination before arriving at conclusions.

4. **The Pelvic Pain of Hysteria.**—When a diagnosis of hysteria has been made in a case presenting symptoms of pelvic pain, the question arises: Shall the patient be treated locally as well as generally? The importance of a general treatment of the individual by seclusion, rest, electricity, and massage, or by the two latter agents, combined with exercise and mental diversion, cannot be

underrated—especially when employed with the thoroughness only possible in a well-equipped private institution. I have, however, noticed that the association of a direct local treatment of the affected part of the body with this general treatment is frequently necessary, and that those so treated respond more quickly to the remedies. This is equally true of hysterical pelvic neuroses as of hysterical aphonia and hysterical paralysis, and one is led to suspect a direct action of the peripheral stimulus on the disordered volitional apparatus.

But local treatment in this class of cases does not demand the scientific exactness requisite in the successful treatment of organic conditions. Internal applications are usually unnecessary in pelvic cases, as in laryngeal cases of hysteria, equally successful results being obtained from external percutaneous applications of whichever current is most convenient. Here, as always in this protean disease, it is the operator rather than the method that determines the result. While local applications to the apparent seat of disease are generally best, a careful discrimination should be used in omitting this part of the treatment in most cases occurring in erethistic subjects. Any kind of local treatment is at times harmful, as tending to fix and deepen the patient's attention upon an organ or function already affected by undue introspection.

CHAPTER XVII.

THE ELECTRICAL TREATMENT OF UTERINE DISPLACEMENTS.

Flexions.—The *rationale* of the recently recommended method of correcting flexions with the faradic current is based upon the view that the uterus is a mus-

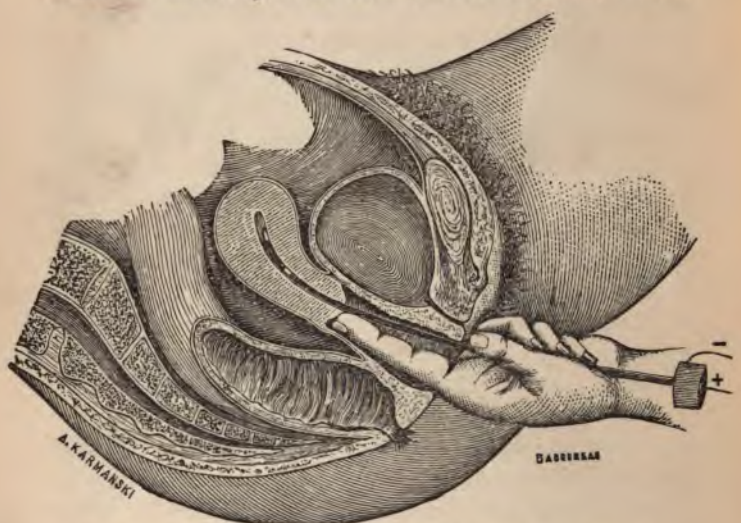

FIG. 39.—APOSTOLI'S BIPOLAR INTRA-UTERINE ELECTRODE IN POSITION.

cular tube which may be atrophied or relaxed on one side, permitting a bending at the point thus weakened. The rapidly successive faradic current is applied directly to the uterine muscle with a view to stimulating the entire organ into a contraction that, for the time at

least, will correct the deformity and lessen any engorgement accompanying it. This is done either after the monopolar method, the negative pole within the uterus and the positive as an abdominal dispersing pole, or the bipolar method of Apostoli is employed (Fig. 39). As these cases usually present difficulties in the insertion of the smallest sound, the usefulness of a more or less clumsy bipolar electrode is frequently limited. The necessity for flexibility is apparent, and in the bending these instruments are liable to crack, admitting moisture that tends to short-circuit the current. My experience with either form of faradic application, used alone in a case, is at present too limited to be of value.

In retroflexions we almost invariably have hypertrophy—doubtless partly a cause and partly an effect of the flexure. In the treatment of such cases, I have had at times excellent results by a combination of the effect of reposition and galvano-chemical cauterization of the cavity, followed by the temporary use of the antiseptic-wool tampon. Rest in bed immediately following the application is to be enforced, if possible, and the whole repeated a week later. During the course of such a treatment the faradic current may be used as an important auxiliary.

It should not be forgotten that endometrial inflammations may at least be associated with both retroflexion and anteflexion, calling for intra-uterine treatment in the absence of symptoms of acute tubal trouble, as in the following example:—

Case XXXVI. *Sharp anteflexion following exertion in a case of endometritis. Failure of reposition. Complete and permanent correction as a result of four posi-*

tive cauterizations.—Annie K., æt. 21, single, applied for treatment at the gynecological clinic of the Pennsylvania Hospital, Out-Patient Department, October 30, 1888. For two months there had been a constant leucorrhœa, tenacious, yellow, and voluminous. One week ago, while lifting a wash-boiler, felt a severe pain in the back accompanied by nausea. Since then has been prostrated, with pain in the back and painful locomotion. Menstruation has been regular, small in amount, and attended with severe pain during the first two days.

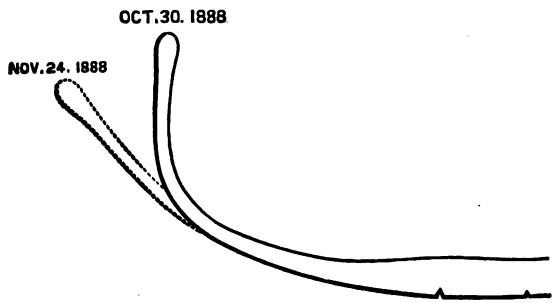

FIG. 40.

Examination showed uterus sharply anteflexed (Fig. 40). Cavity measured two and a half inches, plus.

On this date Dr. Bradford inserted the sound and brought the fundus to a normal position. Injections of hot water and potassium chlorate prescribed.

November 1st. Uterus in slightly better position. Fundus again replaced.

November 6th. Uterus almost in original abnormal condition and subjective symptoms not relieved. Referred to the author for treatment. Positive cauteriza-

tion, eighty milliampères, two minutes. The electrode was bent to the proper curve (see curve of October 30th, Fig. 40) and inserted with some difficulty.

November 8th. Slightly better position. Positive cauterization, fifty-five milliampères, three minutes.

November 13th. Had a sanguineous discharge lasting three days. Straighter sound enters with ease. Positive cauterization, fifty milliampères, three minutes.

November 20th. Felt badly for two days after application; on the fourth day felt perfectly well, and has done so since. Positive cauterization, thirty-five milliampères, three minutes.

November 22d. Cavity much straighter. Positive cauterization, forty milliampères, two minutes. Subjective symptoms have disappeared.

November 24th. Electrode of normal curve inserted with ease (see cut, Fig. 40). Positive cauterization, twenty milliampères, two minutes.

November 27th. Patient remains well. Uterus in normal position.

December 8th. Position remains normal. Menstruation appeared on the 4th instant, lasting three days, without pain.

In the absence of either endometritis or metritis such current doses would be, of course, improper, but in cases characterized by atrophy of one side of the uterus —the side toward which the bend is directed—it is certainly proper to employ galvanic currents of ten to thirty milliampères, for it is well known that this current is most efficient in the stimulation of wasted muscular tissue.

A most important point to remember, however, is that

there can be no doubt of the correctness of the recent views of the causation of many cases of acquired flexions and other displacements which attribute the deviations to old inflammatory adhesions of the uterus to neighboring parts. The whole trouble is really external to the uterine body. In such cases (in the absence of hypertrophy or endometrial catarrh) intra-uterine treatment cannot be other than meddlesome. Here, vaginal applications, sometimes of high powers, are most effective in loosening dense adhesions and removing pain and discomfort.

Versions and Prolapse.—There is likely to be a considerable future to the electrical treatment of displacements due to relaxation of the muscular bodies that maintain the uterus in a normal position, but at present the subject is somewhat theoretical. Dr. A. L. Smith (*American Journal of Obstetrics*, June, 1888), in an elaborate review of the subject, lays particular stress on the existence of muscular fibres in the so-called ligaments of the uterus, as well as on the importance of tone in the vaginal muscular tube in the maintenance of a normal position. From this point of view the condition present in displacements is a muscular insufficiency, varying in degree from simple weakness of the muscles to their complete disappearance from atrophic degeneration. If this be so, it is obvious that mechanical support alone can do no more for their relief than can orthopædic apparatus alone in the treatment of analogous external muscular dystrophies. The rational treatment is a combination of artificial support and gymnastic exercises. As to which feature of the treatment should preponderate is not difficult to decide. The experience

of orthopædists is, that a rigid support, while often most convenient and frequently curative, is yet liable to cause increased weakness of the muscles that are not in use. The gymnastic exercises (inclusive of faradic stimulation), on the other hand, are less liable to abuse, although not removed from the possibility of producing local exhaustion from too great an excitation.

The application of these rules to the treatment of muscular weakness of the vagina is very easily done. If the weakness has stopped short of total disappearance of the muscular fibres, a more or less forcible contraction can be obtained by either the faradic or galvanic current. In the galvanic application the negative pole

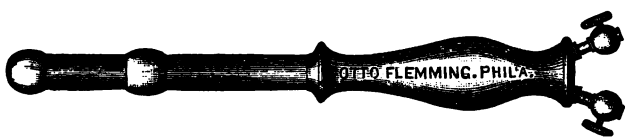

FIG. 41.—AUTHOR'S BIPOLAR VAGINAL ELECTRODE.

should be applied within the vagina and the positive on the abdomen, the monopolar vaginal electrode of large surface shown at page 97 being used, with unbroken currents of ten to thirty milliampères. When currents greater than twenty milliampères are used the active electrode should be kept in motion (labile) for the double purpose of avoiding cauterization and promoting contraction.

The negative pole of the faradic current may be used in a similar way; but I prefer with this current to use the bipolar vaginal electrode, shown in the cut (Fig. 41). This electrode should not be used for galvanic applications unless the metallic surface is incorrodible. Astrin-

gent tampons are probably the best form of artificial support to use in conjunction with these applications.

If there be hyperplasia of the uterus at the same time, its reduction by negative cauterization is a necessary preliminary to muscular treatment; one or two applications of from fifty to one hundred milliampères will usually be sufficient, but the application of this amount of current to a displaced uterus should be invariably followed by rest in the recumbent position for from six to twenty-four hours.

A concentration of current upon the anterior or posterior ligaments in cases of simple version is, of course, more difficult than the vaginal applications. It has been advised that the active electrode be placed in the bladder in retroversion, and in the rectum in anteversion. Intrauterine application to all the parts at the same time will frequently suffice, particularly if adhesions be present, as a faradic current of great strength may be painlessly applied in this situation.

CHAPTER XVIII.

THE ELECTRICAL TREATMENT OF EXTRA-UTERINE PREGNANCY.

RIGHTLY considered, there is no conflict whatever between laparotomy and electricity in the treatment of this accident. The consensus of intelligent opinion in America inclines at the present time somewhat as follows:—

If rupture has occurred, an immediate laparotomy should be performed and the mass extracted, if an operator skilled in such work is in charge or can be obtained. If no operator is at hand, it is, of course, possible that the woman may survive the rupture without removal of the offending materials, though such a termination is unlikely: but no electrical treatment of any kind should be used at this time. After all acute irritation has subsided, negative vaginal or uterine applications of the galvanic current (ten to twenty milliampères) should be used to promote absorption of the resulting tumor. An immediate application of either current to the ruptured cyst is highly improper and likely to aggravate the mischief.

If, on the other hand, an extra-uterine pregnancy be diagnosed before rupture and prior to the fourth month, an electrical treatment is highly proper and will, most likely, result in a complete cure. But the object for which electricity is thus used should be clearly understood. To kill the fœtus is the only purpose at first. In accomplishing this, the faradic current is decidedly

most appropriate, as shock and arrest of circulation are, doubtless, the modes of death, and these require current interruption. Interrupted galvanic currents are equally effective, but are unnecessarily painful to the woman.

In applying the current the sac is included between a large moist electrode placed on the skin above it and a bulb-electrode placed either in the vagina or rectum. The internal electrode should be negative, and is merely pressed against the vaginal or rectal wall in the direction of the sac. There is no occasion whatever for electro-puncture, as a fatal concentration of the faradic current is usually passed through the intervening tissues with ease. The strength of the current should not be great, as there is some risk of rupturing the cyst if strong currents are used, causing violent contractions of the abdominal walls. This latter action is lessened if the abdominal electrode is large. This procedure may be repeated daily for several days to make sure of the results.

After the vitality of the ovum has been arrested two courses are open to the surgeon: either laparotomy for the removal of the dead mass, which is now more safely performed, or a mere promotion of the efforts of nature in removing the mass by absorption. The latter course will commend itself to many, since a number of instances are now on record where an electrically killed ovum has either partially or completely disappeared from the abdominal cavity. Brothers* has collected a list of forty-three cases treated by electricity. In two of these electro-puncture was used; in twenty-one, the

* *American Journal of Obstetrics*, May, 1888, p. 474.

faradic current; in sixteen, the galvanic; in two, both currents; in one, the franklinic; and in one the exact current used was not stated.

Of these cases, two terminated fatally. One of these, a case of Braxton Hicks, died from an aspirating puncture made five weeks after the electricity had been used. The other death was apparently attributable to the electrical application, an artery in the sac bursting during the procedure.

In all the cases mentioned in this list, except two, the fœtus was killed by the current, and, with the other exceptions mentioned, the tumor is variously stated as shrinking or disappearing. Of the two excepted cases the fœtus was expelled from the tube into the uterus in one, where it continued to grow until delivered at term (Garrigues). In the other the method was abandoned after two trials.

Brothers has recently (*American Journal of Obstetrics*, February, 1890, p. 113) presented a carefully-drawn report of the subsequent history of these cases. Twenty-five cases had been observed for periods ranging between one and eight years after the employment of electricity. Of these at least fourteen were under observation for periods longer than three years. In eight cases a thickening or distinct tumor is referred to as present at the time of the last examination, in nine cases the local condition is not mentioned, and in the remaining eight cases nothing was found. In one case the woman presented symptoms of suppuration, but these passed away in time and required no surgical interference. In none of the other cases did the tumor seem to cause the slightest inconvenience,

six of the women going through subsequent normal pregnancies.

His conclusions are :—

1. The risk of rupturing the sac of an extra-uterine pregnancy and causing death by internal hemorrhage is slight. In but one case has this possibly occurred, but the reporter himself thought that the damage existed prior to the employment of electricity.

2. Suppuration of the dead fœtal mass has not occurred in any case in which electricity was employed before the third month.

3. Beyond the third or possibly fourth month electricity should not be resorted to.

4. Electro-puncture is to be condemned in all cases.

5. In all cases of mistaken diagnosis no harm is done by the electrical treatment.

6. Under galvanic or faradic currents early extra-uterine pregnancies can be checked in their growth and caused to disappear entirely, or to become shriveled up. These remaining masses have thus far caused no subsequent trouble.

CHAPTER XIX.

THE ELECTRICAL TREATMENT OF MISCELLANEOUS CONDITIONS.

Amenorrhœa.—My experience justifies a most emphatic indorsement of the claims put forward by Engelmann respecting the value of electricity in cases of completely suppressed or scanty menstruation. In the negative pole of the galvanic current we have an agent that is all-powerful in the promotion of a normal flow, but this form of direct treatment is to be recommended only when there are local morbid conditions present that warrant intra-uterine applications. That a careful diagnosis should be made to exclude pregnancy, goes, of course, without saying. In cases I, IV, and XXV, reported in detail in these pages, a careful reading of the notes will show that a scanty or absent menstruation existed in each before treatment. In each case an increased flow resulted from negative cauterization. Case I, in addition to the small fibroid that existed, was an instance of complete suppression that had lasted eleven months. As a result of two negative intra-uterine applications a normal flow appeared, which has recurred monthly since. Engelmann reports two cases in which intra-uterine faradic applications were followed by equally good results.

But our resources for the treatment of amenorrhœa are also markedly increased by electricity in those cases in which it is unnecessary to make a local examination.

APPENDIX.

The Law of Ohm and its Graphic Representation.—This important formulation of the conditions determining the power of currents is readily understood by any one who has performed the experiments detailed in Chapter III. While the experiments themselves, if faithfully followed, give a grasp of the subject that much theoretical study often fails to impart, no expert user of electricity should rest content until the law and its consequences are thoroughly mastered. It is only then that the relative value of large and small cells is understood, together with their proper arrangement for producing electrolysis or heating the galvanic knife.

The law is simply that the ampères equal the volts divided by the ohms; or, ampères = volts ÷ ohms. Put into figures, it is found that if we have ten volts in a circuit with a resistance of five ohms, there is a current of two ampères circulating. The simplicity of this mathematical proposition is self-evident; yet, when we are dealing with a battery of cells as the producer of the current, and are attempting to adjust the latter to our needs, the simplicity is marred by the fact that a proportion of the ohms of resistance is within the cells themselves, or *internal resistance*, as contrasted with the resistance of the circuit outside the cells, or the *external resistance.* If we wish heavy currents from a battery, the law of Ohm tells us exactly when this internal resistance is in our way and when it is not in our way; in other words,

whether we need a few large cells, or many cells that do not need to be large.

To the mathematical mind but little effort is required to comprehend such facts. To those rusty in figures I commend the following graphic delineation of the law of Ohm, as applied to cell-batteries.

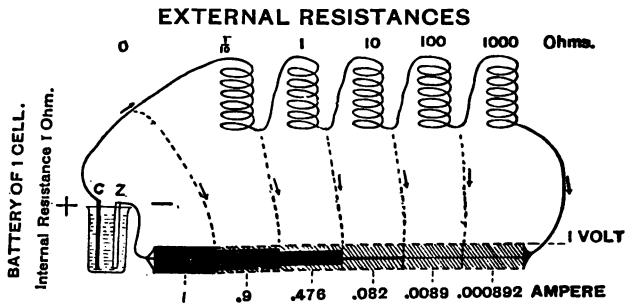

FIG. 42.—GRAPHIC DELINEATION OF THE VOLUMES AND PRESSURE OF CURRENTS FROM A SINGLE GALVANIC CELL WHEN VARIOUS RESISTANCES ARE INSERTED INTO THE EXTERNAL CIRCUIT.—The cell shown at the left of the cut has an electro-motive pressure of one volt and an internal resistance of one ohm. The divisions of the drawing to the right of the cell represent imaginary longitudinal sections of the currents obtained on short-circuiting the cell and after successively inserting into the circuit the several resistance coils indicated in the upper portion of the figure. The heavy shading in the first three divisions shows the exact proportion of volume to the eye as compared with a full ampère, indicated by a broken line. The light shading shows the proportion of pressure, which is uniformly maintained throughout. The volume in the last three spaces is indicated by the figures beneath, but is much too small to be shown to the eye on the scale adopted.

Fig. 42 shows to the eye the effect made on the current volume from a single cell by inserting various amounts of resistance into the external circuit. The cell has a typical pressure of one volt and a typical internal resistance of one ohm. When its terminals are joined by

a short band of copper, so thick as to present no appreciable resistance, the current volume produced is one ampère. If, now, the short band of copper be replaced

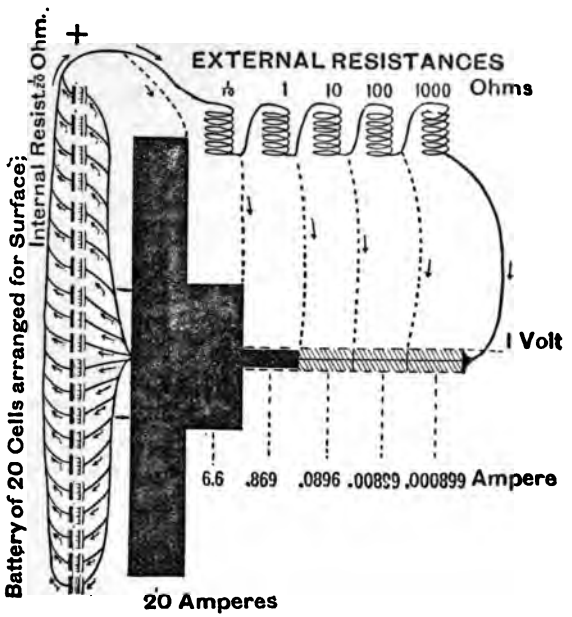

FIG. 43.—GRAPHIC DELINEATION OF THE VOLUMES AND PRESSURE OF CURRENTS FROM A BATTERY OF TWENTY CELLS ARRANGED FOR "SURFACE."—The battery, acting as an enlarged cell, has an electromotive pressure of one volt and an internal resistance of one-twentieth of an ohm. The first three imaginary current sections show the proportions of volume to the eye.

by a coil presenting a resistance of one-tenth ohm, making, together with the internal resistance of the cell, a total of one and one-tenth ohms, the resultant volume will be diminished to nine-tenths of an ohm.

When another coil, giving a resistance of a full ohm, is added, the total now being two and one-tenth ohms, the volume maintained is less than half an ampère. A corresponding reduction of the volume occurs, with the inclusion of each additional amount of resistance in the external circuit; and when the whole series of coils is placed in circuit, aggregating, together with the internal resistance, a total of one thousand one hundred and twelve and one-tenth ohms, the current volume is brought down to less than nine-tenths of a milliampère.

The resistance of the body with approved electrodes may be said to be represented by the last two coils of the figure (from one hundred to one thousand ohms), while that of the platinum loop of the galvano-cautery knife is nearest that of the first coil. The effect of increasing the cell to twenty times its size (or coupling twenty similar cells for surface, *i.e.*, all the zincs to one pole and all the carbons to the other) is shown for both uses in Fig. 43, demonstrating the value of the method with the slight external resistance and its inefficacy for the greater. The effect of an increase in the voltage in passing more current through the higher resistances is shown in Fig. 44, which also displays the disadvantage of this method in the low resistances, as the additional cells bring with them additional internal resistance.

Current Diffusion Within the Body.—The human body conducts currents with a reasonable ease because of its watery and saline constituents. Grossly speaking, those parts that are most watery are, therefore, the chosen paths of transit through the body, a greater proportion of current going through the soft tissues around bones and nerves than will take the apparently shorter

cut through them. Such considerations are important when we are compelled to depend upon interpolar

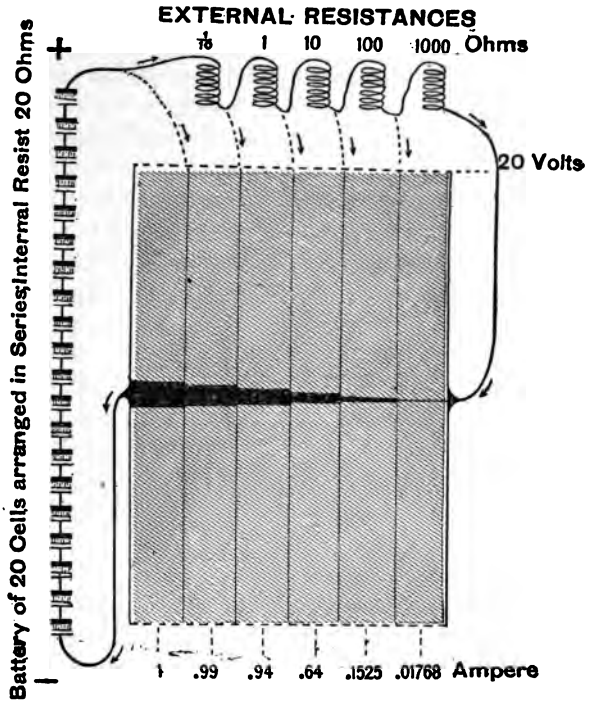

FIG. 44. — GRAPHIC DELINEATION OF THE VOLUMES AND PRESSURE OF CURRENTS FROM A BATTERY OF TWENTY CELLS ARRANGED IN "SERIES."—The battery has an electromotive pressure of twenty volts and an internal resistance of twenty ohms. The heavy shading in the first five imaginary current sections shows the exact proportion of volume on the scale of the preceding cuts. The space allotted to represent pressure is reduced to one-half the scale adopted in Figs. 42 and 43 for purposes of convenience.

action for therapeutic effect, and desire to send a dense current through a region beyond immediate contact with

the electrode. Of still greater importance is a clear idea of current diffusion in the body as a whole. To suppose that we can send a current through the body like a straight beam of light, or even in the bellied cylinders depicted by Erb, is to ignore well-known laws of resistance and current diffusion. The author pointed out some years ago* that a demonstration of the real facts of much importance to physicians is contained in Prof. W. G. Adams' experimental measurements of current diffusion within masses of salt water.† Buckets and tubs of salt water, and various acid solutions were used for experiments, the character of the solutions and the shapes of

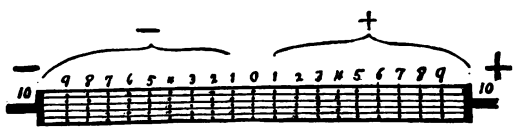

FIG. 45.—DIAGRAM SHOWING THE DISTRIBUTION OF A CURRENT OF TWENTY VOLTS WITHIN A NARROW CONDUCTOR.—The milliampères are equally distributed in the lines of flow (represented in the cut by horizontal lines). The lines of equal potential (represented in the cut by dotted lines) are drawn one volt apart, and have a value indicated by the figures.

the utensils presenting conditions closely analogous to the human body. To illustrate the facts thus verified, I have drawn three diagrams (Figs. 45, 46, and 47) in which the behavior of a current traversing narrow and wide conductors is shown. The lines of flow are seen in each instance to cross the dotted lines at right angles. These dotted lines are lines of equal potential. Exactly what equipotential lines in electricity are can be best

* *Journal Nervous and Mental Disease*, No. 7, 1886.

† Proc. Royal Society, vol. xxiv, p. 1. See, also, a theoretical discussion by Foster and Lodge, Proc. Lond. Phys. Soc., vol. i, p. 113.

understood when it is known that they are analogous to the edges of the steps of a staircase down which a water-current is flowing. In this case it is assumed that the middle step is zero, or at the level of the earth (making it analogous to a staircase with the middle step at street-level, and each half of the remainder going up stairs and down cellar).

In the narrow conductor (Fig. 45) the equipotential lines, or, in illustrative language, the edges of these steps of electric level, extend straight across the conductor, the lines of flow being straight lines from pole to pole. In the wider conductor (Fig. 46) the lines of

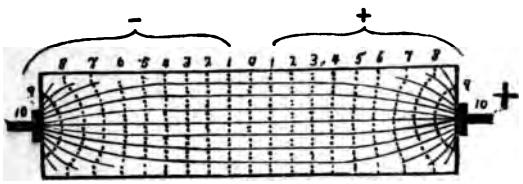

FIG. 46.—DISTRIBUTION OF A CURRENT OF TWENTY VOLTS WITHIN A WIDER CONDUCTOR.—The lines of flow on either side of the central one curve somewhat, as do also the most positive and most negative potentials.

potential tend to curve somewhat about the poles; hence the lines of flow on either side of the centre one, which remains straight, curve a little also, as the potential lines must be crossed at right angles.

When the current is passed through so large a conductor as the human body (Fig. 47), the potential lines become arcs of small circles about each pole, the size of the circles rapidly increasing as we proceed away from the poles. The lines of flow traverse every portion of the conductor as before, crossing the equipotential lines

at right angles, and differ in amount of current carried only in inverse ratio to their length.

It is necessary to add that these diagrams represent the distribution in a homogeneous conductor, such as a single organ, and that slight alterations would be re-

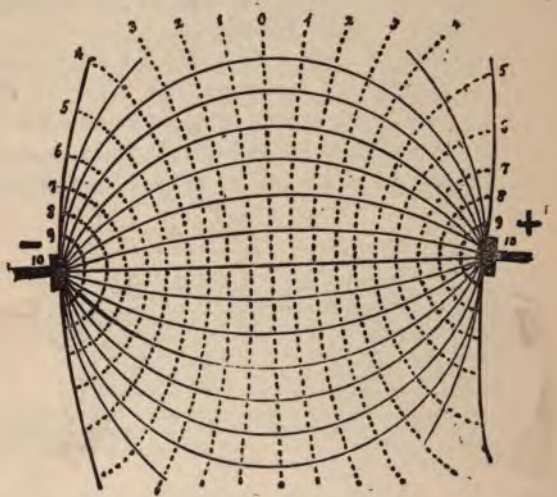

FIG. 47.—DISTRIBUTION OF A CURRENT OF TWENTY VOLTS WITHIN THE HUMAN BODY.—The equipotential lines or planes become segments of perfect circles, and the lines of flow, necessarily crossing the latter at right angles, become greatly curved and extend to all parts of the body in passing from pole to pole. The number of milliampères traversing the lines of flow differs somewhat, being inversely proportional to the length of the lines.

quired to make them represent accurately any composite conductor like the body. An accurate chart of the soft parts, nevertheless, would only add waviness to the lines as drawn, though bones and bony cavities would deflect them greatly. It should also be remembered that the

diagrams represent a section only, and that the equipotential lines are, in reality, cup-shaped planes through which the lines of flow spread in all directions.

Directions for Covering Electrode Disks with Absorbent Cotton.—The ordinary disk electrode used in muscular stimulation is generally sent to physicians with a covering of sponge. This is an excellent means of retaining the needed moisture between the metal and the skin if the battery is to be used with a single case,

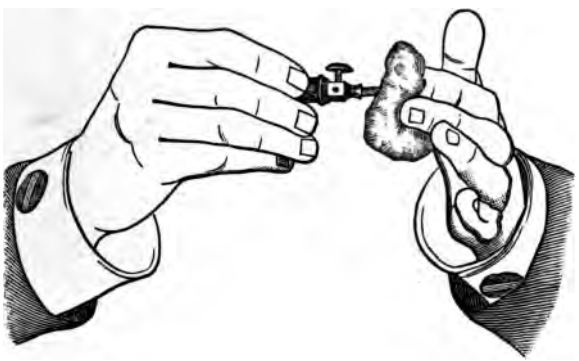

FIG. 48.—COVERING AN ELECTRODE DISK WITH ABSORBENT COTTON (FIRST STAGE).

but in a physician's practice such coverings soon become too filthy to be tolerated, and should be replaced by absorbent cotton, freshly applied for each case. This may be done in a few moments as follows: Take a thick pinch of absorbent cotton of even texture, somewhat larger than the disk to be covered, and, holding it on the fingers of the left hand (Fig. 48), place the disk on it, carry the edges up to the shank, and fix them in that position by a

twisting motion of the electrode (Fig. 49). An additional twist after it is wet serves to fix it more firmly. New electrodes are not as good as old ones for this manœuvre, but the new ones may be made to take the cotton by roughening or milling their edges. The cotton should be kept abundantly wet with warm water when in use.

Directions for Amalgamating the Zincs.—All zinc plates used in acid solutions should continuously present a bright, silvery color, due to an abundance of mercury

FIG. 49.—COVERING AN ELECTRODE DISK WITH ABSORBENT COTTON (SECOND STAGE).

on their surface. Whenever they become blackened or rusty this coating should be renewed by dipping them alternately in fresh battery fluid and mercury. If a good quantity can be made to adhere to any immersed portion of the plate it will diffuse itself subsequently over the whole surface under the action of the fluid.

Directions for Making the Battery Fluid.—The fluid to be used in portable galvanic batteries and in the cells of most portable faradic batteries is made according

to the following directions, the formula first given being the preferable one. The second formula may be used in case the bichromate of soda is not available.

No. 1. Dissolve four (4) ounces of bichromate of soda in one (1) quart of hot water in an earthenware or glazed-iron vessel. When cooled off, add to it four (4) fluidounces of commercial sulphuric acid and one-half (½) ounce of bisulphate of mercury. Mix well. The addition of bisulphate of mercury, while it may be dispensed with, tends toward improving the condition of the zinc plates.

No. 2. Dissolve one and a half (1½) ounces of bichromate of potassium in twenty-four (24) fluidounces of hot water in an earthenware vessel and add to it three-fourths (¾) ounce of saltpetre. Allow it to cool to the temperature of the air, and then add three (3) fluidounces of commercial sulphuric acid. When cold, add a solution of one-half (½) ounce of bisulphate of mercury in three (3) fluidounces of cold water, with a little sulphuric acid added to it. This quantum will yield one quart of the battery fluid, and should not be used until cold.

This fluid should be changed if the battery shows signs of weakening. Its exhaustion is shown in the appearance of a bottle-green color at the edges, or when seen in a thin layer.

A New Portable Faradic Battery.—In response to the author's suggestion, Mr. Otto Flemming has begun the manufacture of a new form of portable faradic apparatus which he has called the Vola Battery (Fig. 50). This battery embodies, in a portable shape, all the advantages of a Du Bois Reymond coil, permitting an increase and decrease of current to its full capacity

without shock. This is, of course, particularly useful in gynecological work. A slow interrupter is added, making it complete for neurological uses. An important feature is the use of two dry cells as the actuating agent, getting rid of the annoyances of fluid, and keeping the battery ready for only occasional work. It is

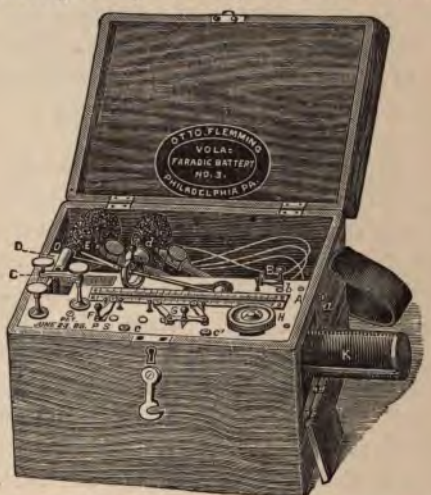

FIG. 50. — The VOLA FARADIC BATTERY.—A, platform; B, switch for putting battery in action and out of action; C, contact screw-lever functionating rapid and slow interrupter; D, rapid vibrating interrupter; E, slow interrupter; F, switch for selecting the primary or secondary induced currents; G, commutator; H, governing handle for graduating both secondary and primary currents; I, guide and index indicating position of coils; K, movable secondary induction coil.

claimed that one cell has been worked constantly for nineteen hours before exhaustion. In using this battery it is important to remember that the coil, K, should be drawn out to its full extent in beginning the use of the secondary current, and *vice versâ* with the primary.

FIG. 51.—WALL CABINET, ARRANGED FOR AUTHOR'S CURRENT CONTROLLER.—This cabinet contains: 1. The "Massey" Current Controller, for the purpose of varying the galvanic current at will, by rapidly increasing or decreasing the resistance in the circuit. 2. The Milliampère Meter, for indicating the number of units of electricity passing through the entire circuit, including the patient. 3. The Single Switch, for including or omitting the Milliampère Meter in the galvanic circuit. 4. The "De Watteville" Current Combiner, for combining the two currents (galvanic or faradic) simultaneously, and also for selecting either one or the other. 5. The Commutator (or pole-changer) and the two terminal posts a' and a''. 6. The Du Bois Reymond Induction Coil, with slow and rapid interruptions and graduator. 7. The Water Rheostat, for varying the faradic current by inserting a range of resistance into the circuit. 8. The Single Switch, for omitting or including the Water Rheostat in the faradic circuit. 9. The Faradic Double Switch, for selecting either the primary or secondary induction currents. 10. The Single Switch, for starting or stopping the electric action in the faradic apparatus.

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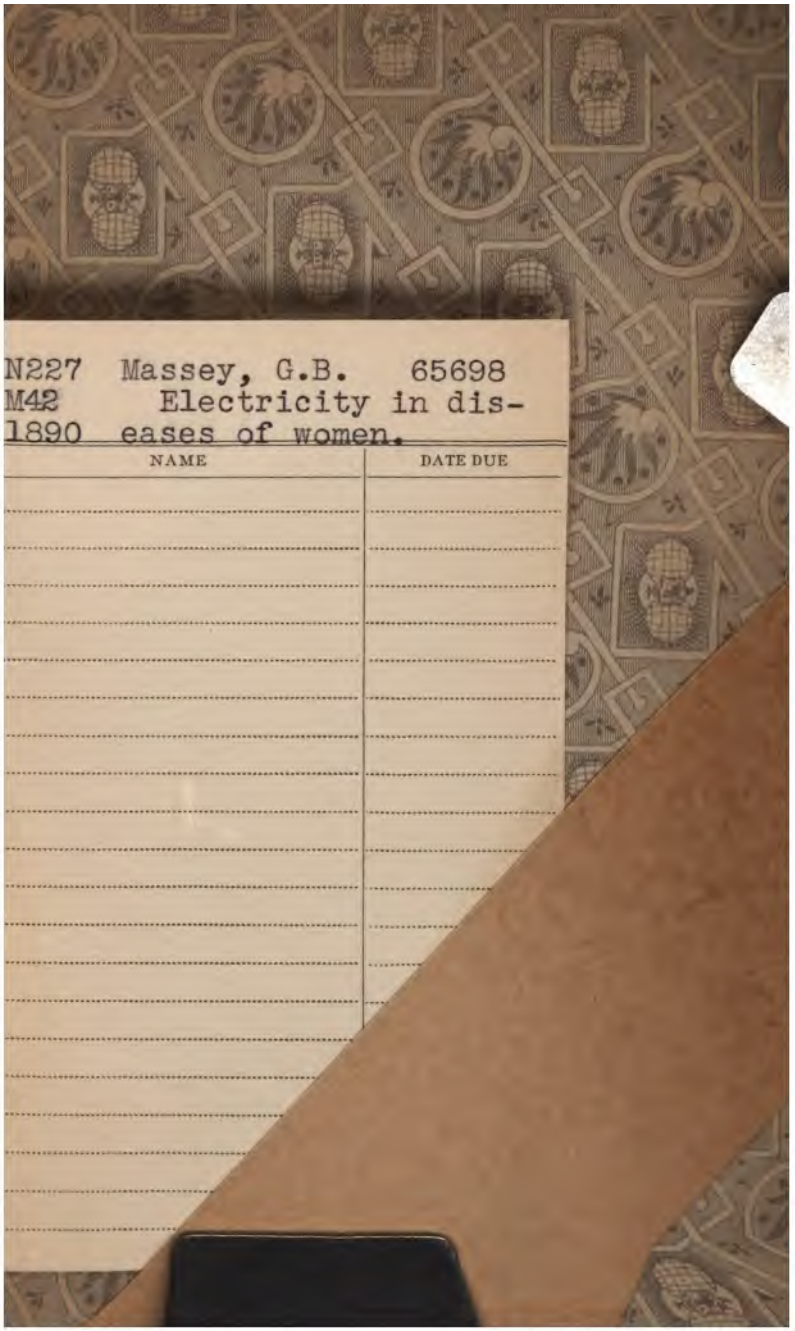

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